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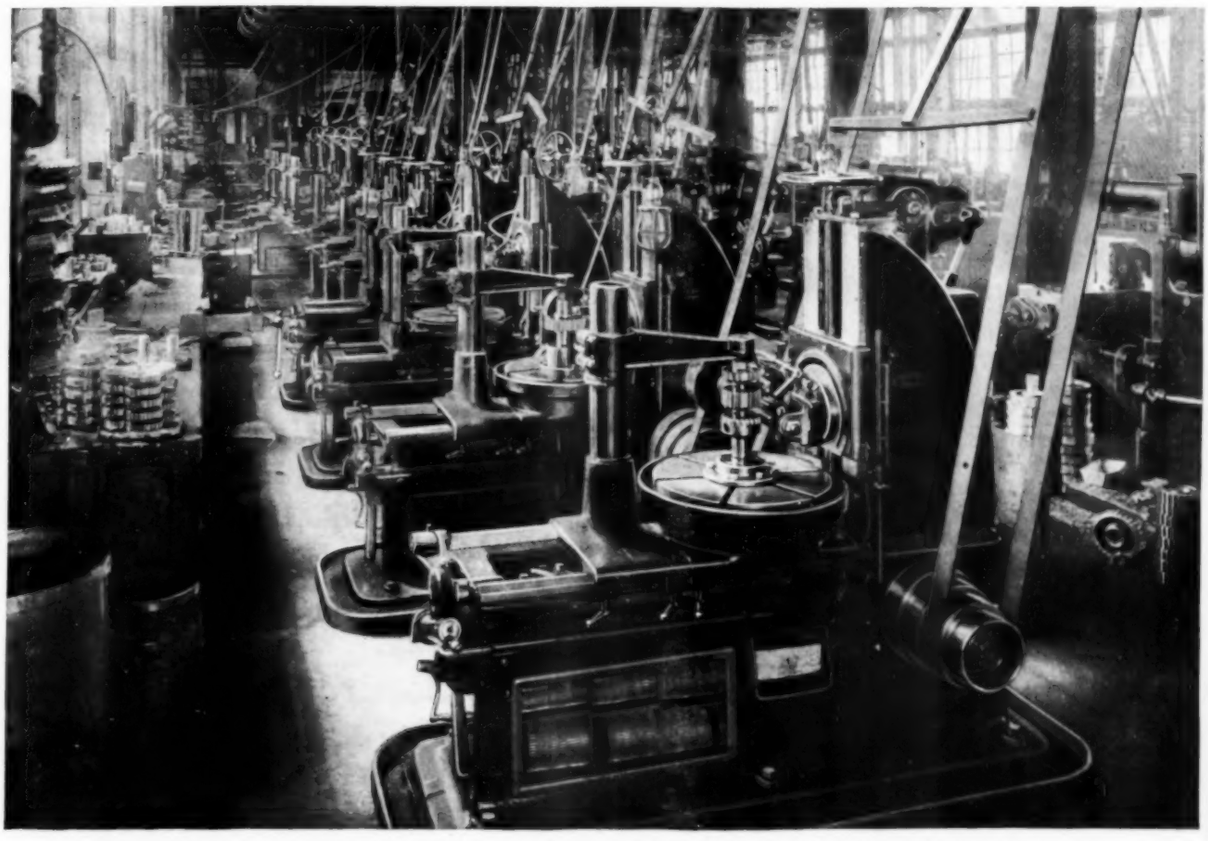

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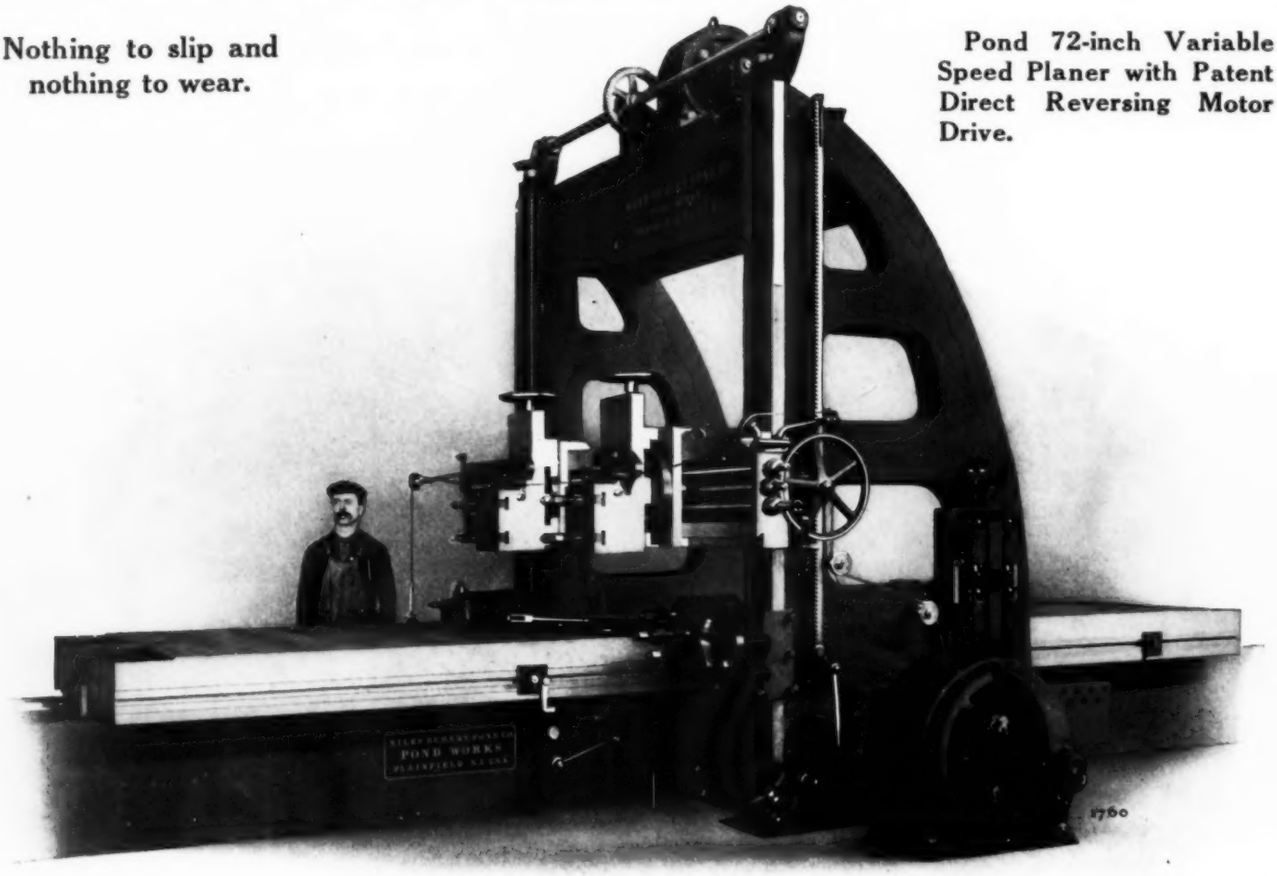

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(*See pages* 43, 44, 45 46 *and* 47)

Manufacturing Jewels for Watches

By F. A. Stanley

Sapphire jewels for watches and other mechanisms are manufactured and used by the millions in this country alone.

The equipment employed by a Waltham manufacturer in finishing the various forms of jewels from the rough Montana sapphire.

How the stones are held, lapped down, chipped, turned, drilled and finished at a remarkable rate of speed.

Watch manufacturers of this country use annually several millions of jewels, and makers of certain classes of instruments also make use of jewels in large quantities. There is, in fact, a steady increase in the number of jeweled bearings applied by instrument makers to such devices as recording and other electrical meters, gages, etc.

While large quantities of these jewels are imported, a great many are made here at home. The processes of manufacture which carry the rough stone to its finished condition mounted in its setting, ready for dropping into place into watch or other mechanism, comprise a series of most interesting operations, a number of which are illustrated by the accompanying engravings. These views show some of the methods used in the shop of John Worley, the well known jewel manufacturer, of Waltham, Mass.

A Little Personal History

Mr. Worley has been engaged in jewel manufacturing for fully 30 years and naturally understands every phase of the business. Born in Coventry, England, he worked for ten years in early life in that city in making jewels, and after arriving in this country spent some nine years in similar work at the factory of the Waltham Watch Company. For the past 11 years he has been engaged in business for himself as a manufacturer of the different classes of jewels.

Where the Rough Jewels Come From

There are several sources of supply for the rough sapphires from which the jewels are cut, chief of which are Ceylon, Australia and Montana. Curiously enough, while we are apt to think of sapphires as blue, they actually are found in about all colors of the rainbow. The Australian stone is the hardest and correspondingly brittle. The stone from Ceylon is not quite so hard, and is less brittle. The Montana stone is said to be best for jewels in mechanisms where any strength is required, as it is less brittle than the others, and therefore not so easily fractured. The Montana stones are sorted out as taken from the mine, and those distributed to jewel manufacturers are generally of a light green color, the more valuable stones being reserved for settings in rings and other jewelry.

The sapphire in the rough and in various stages through which it progresses in the finishing of the jewel is illustrated (about three times actual size) by the upper row of objects in Fig. 1. The two specimens in the lower portion of the view are flawed, and therefore useless stones, of which large numbers are discovered and thrown out during the process of jewel manufacture.

Fig. 2 is an enlarged view of jewels of different forms and Fig. 3 is an enlarged section, through two typical jewel settings showing balance jewels, one with olived hole and end stone, and the other with straight hole.

Operating on the Rough Sapphire

In Fig. 4 a pile of rough stones is shown on the bench ready to be lapped down in the roughing-out process which prepares the jewel for turning and boring. These stones commonly range in size from a rough diameter of about one-quarter inch to three-eighths inch. The first operation consists in placing a rough stone in a cavity formed in the end of a short, wooden holder, which enables the operator to press the stone with his fingers against the face of the copper lap on the B. C. Ames bench lathe seen in Fig. 4. This lap is about five inches in diameter and is charged with diamond dust, which faces off the end of the stone very rapidly as it is moved across the face of the lap. A small stream of water is run upon the sponge and across the lap constantly, to wash away the sapphire dust and prevent clogging of the lap face.

After a quantity of the sapphires have

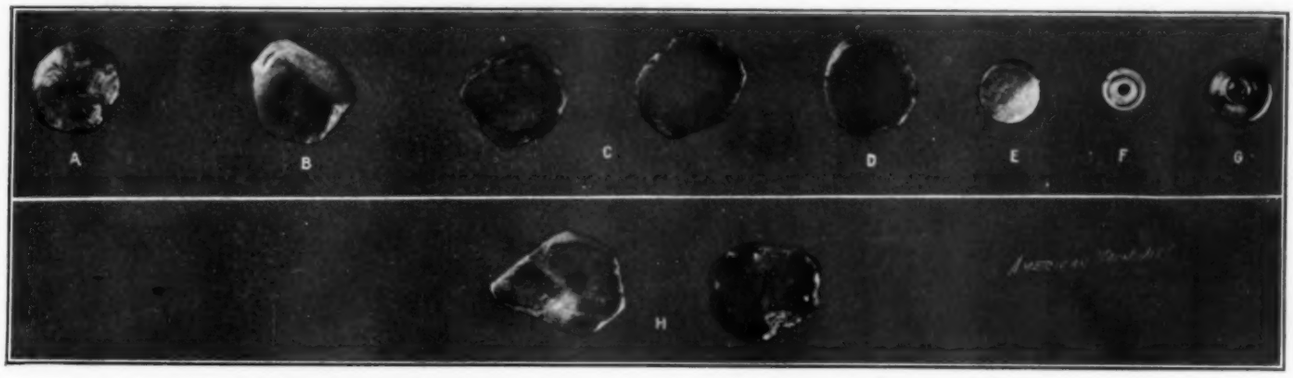


Fig. 1. The Sapphire in Various Stages from Rough Stone to Set Jewel (Shown About Three Times Actual Size)

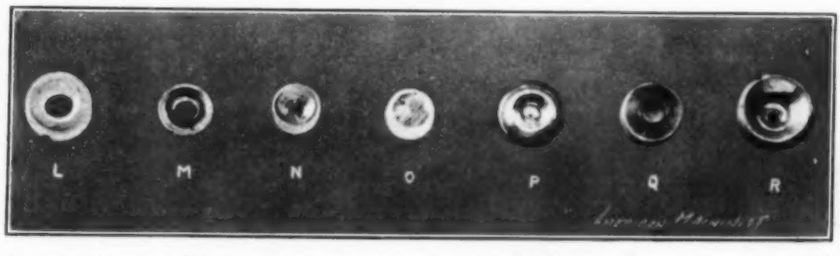


Fig. 2. Several Types of Jewels (Shown About Three Times Actual Size)

been ground down in this way from the rough form at *A*, Fig. 1, until they present, as at *B*, a good, smooth face of about as large a diameter as is obtainable from the stone, they are stuck face downward upon a 1¼-inch steel disk, Fig. 6, which holds perhaps 25 or 30 stones. Here they are firmly held by shellac, which is applied in stick form melted at a low temperature and run on the disk face to a sufficient depth to hold the stones securely when the shellac hardens. In setting, the stones are held down upon the shellacked surface by the hand press on the bench, pieces of rubber being used between the work and press to prevent injuring the sapphires.

The disk *I*, Fig. 6, with its face covered with the stones, as at *J*, Fig. 6, is then against the tailstock rest and pressed against the lap, as in Fig. 5, until the outer faces are ground down, like *K*, Fig. 6, giving the required thickness of stone. The test for thickness is made on the Ames gage, shown in Fig. 4, and as this is

The Copper Lap

Right here, a few words regarding the lapping disk may be of interest. There are actually two such disks used in grinding the rough stones down to the jewel blanks. The first lap, which does most of the work, is charged with quite coarse

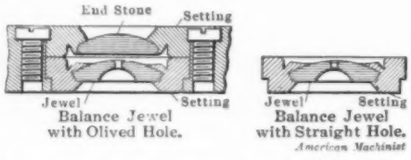


Fig. 3. Two Typical Jewel Settings Enlarged

diamond grains, which can hardly be called powder. The other disk with which the faces of the sapphire blanks are given a very smooth finish, carries No. 1 diamond, which removes about six or eight thousandths of an inch of material.

ordinary method of rolling diamond powder into the lap tends to give a smoother surface than is desirable for a free-cutting lap. The material, when pounded in under the hammer, is driven in in its rough condition and, if still further crushed under the hammer blow, is, nevertheless, forced into the copper, and the blow which sinks into the soft face also causes the copper to hold the particles of diamond fast. The disk thus constitutes a very durable lap and one which cuts with freedom for a long period.

Dressing the Blank Edges

Following the grinding down of the stone to thickness for the rough blank, which then appears like *C*, Fig. 1, the workman with a jeweler's glass examines the blank critically for flaws of any kind, and, while holding the blank as in Fig. 7, with a piece of an old file in his left hand which presses the stone down upon the steel block on the bench, he chips the edge of the stone to an approximately

Fig. 4. Lapping Down a Flat Face on the Sapphire

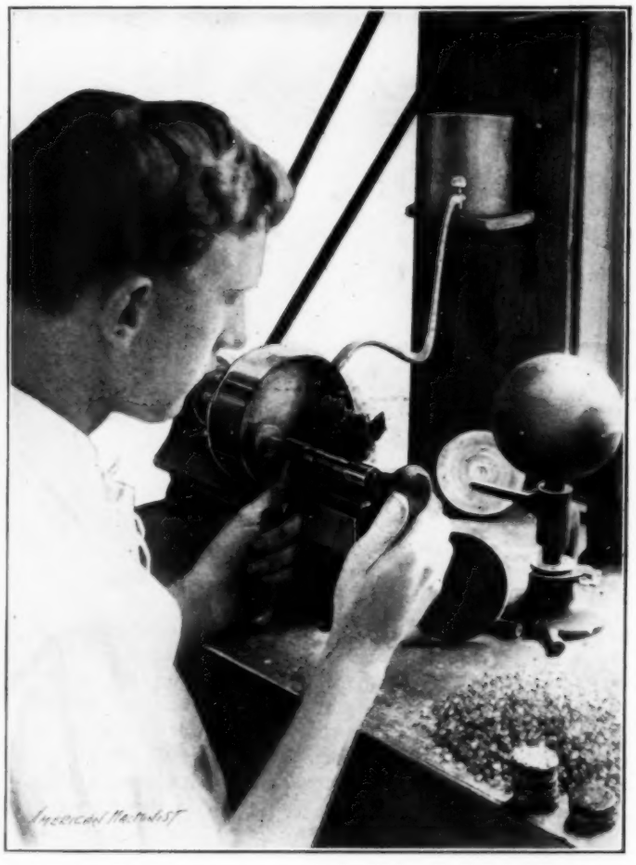


Fig. 5. Lapping Off the Opposite Faces of the Sapphires

a roughing-down operation, some leeway is permitted in the thickness of the jewel blank. The latitude allowed may be expressed as five or ten degrees which, in the watch trade, means five or ten thousandths of a centimeter, or five or ten hundredths of a millimeter, or, again, two to four thousandths of an inch.

Mr. Worley charges his laps by pounding the diamond powder into the face of the copper disk. The powder, which is mixed with olive oil, is smeared over the face of the lap, and a light hammer is then resorted to for pounding the diamond into the copper surface. Mr. Worley has found in his work that the or-

circular outline, avoiding, if possible, any flaw which he may discover in the structure of the stone.

Judgment is required here in order to avoid waste of time in trying to chip out a blank when a flaw across the surface will make it impossible to save the blank. The workmen soon learn, however, just

how large a disk they can cut from any blank, and very few flawed stones pass undiscovered in this operation. In this chipping out process, fully 40 per cent. of the blanks which have been ground down are thrown aside as useless because of the flaws, which give the material the appearance indicated at *H*, Fig. 1.

Turning the Jewel Blanks

After the blanks have been chipped out roughly to diameter as represented by *D*, Fig. 1, they go to the lathe, Fig. 8, where the outside is turned and the hole drilled and opened as at *E* and *F*, Fig. 1. For turning, the operator places the blank upon the end of an arbor projecting from the chuck, the work being held by cement. A small gas flame swung under the arbor for an instant softens the cement, which hardens immediately, when the jewel is pressed against the arbor end. The man trues up the running blank in an instant before the cement has fully set, and then with a diamond tool he turns the periphery and brings the jewel to the required diameter. So skilful does one become who follows this work day after day, that no calipering devices of any kind are resorted to during the sizing process. The eye is relied upon and seldom errs. To be sure, a gage is made for different sizes of jewels, but this is seldom referred to by the skilled workman, who has found that he can hold the jewel practically dead to size without difficulty.

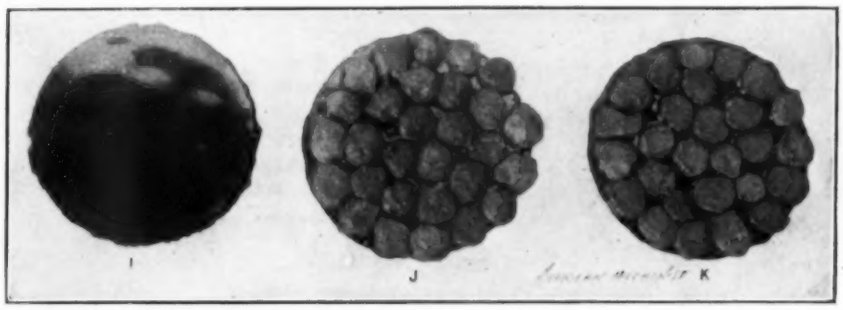


Fig. 6. The Holding Disk Coated with Shellac and Covered with Sapphires

Following the turning operation, the jewel may be placed either in the draw-in chuck or held by cementing to the end of an arbor, while the hole is drilled through the center and opened out front and back.

Drilling and Opening Jewel Holes

A diamond drill is applied to the face of the jewel, and quickly puts a hole clear through it. If the jewel is to be olived, that is, if the hole is to be curved top and bottom of the center, as shown by the section to the left in Fig. 3, a wire opening pin, charged with diamond powder is passed through the hole and swung back and forth, as in Fig. 9, to grind away the sapphire in both faces of the jewel.

This jewel with olived hole is used in connection with an end stone, as in the sketch, Fig. 3, which takes the end pressure of the pivot, while the cleared hole forms the locating and carrying bearing. This form of jewel with end stone is used with watch balance staffs and escapement pivots. Where the jewel is made with a straight hole (for square-shouldered train pivots) the process of drilling is, of course, somewhat simplified.

Here again, as in the turning operation, the workman gages the hole size without reference to mechanical gages of any kind, although he is allowed only two degrees leeway in the hole diameter; that is, the hole must be within three-quarters of a thousandth of an inch of size.

Fig. 7. Chipping the Edges of the Blanks

Fig. 8. Turning the Jewel

Special Forms of Bearings

Frequently, jewels are made of cup form or with a shallow recess to permit some floating action in the running member; also for certain classes of work they are made with a V-shaped hole of about 45 degrees included angle. One of the cup jewels is shown at *N*, Fig. 2. In all cases, whether the hole goes clear through or is a blind opening, it must be highly polished with a boxwood needle charged with diamond dust.

In the case of jewels with conical-shaped bearing opening, this hole is put in with a diamond drill brought to a perfect point. It is a very delicate tool, and is kept to shape by chipping with another diamond which has naturally to be applied with a considerable degree of skill. It is also a delicate matter to polish the bearing of such a jewel to the required degree of nicety. The boxwood point, by which the diamond-polishing medium is applied to the conical hole, is itself driven at a high rate of speed through the flexible shaft shown in Fig. 10. This shaft is operated at something like twenty thousand revolutions per minute and the lathe spindle with the jewel runs in the opposite direction at not less than forty-five thousand revolutions per minute. This high rate of speed, together with experience and a certain degree of patience upon the part of the operator, enables the jewel to be finished so smoothly as to make it impossible to detect any imperfections whatsoever in the bearing surface.

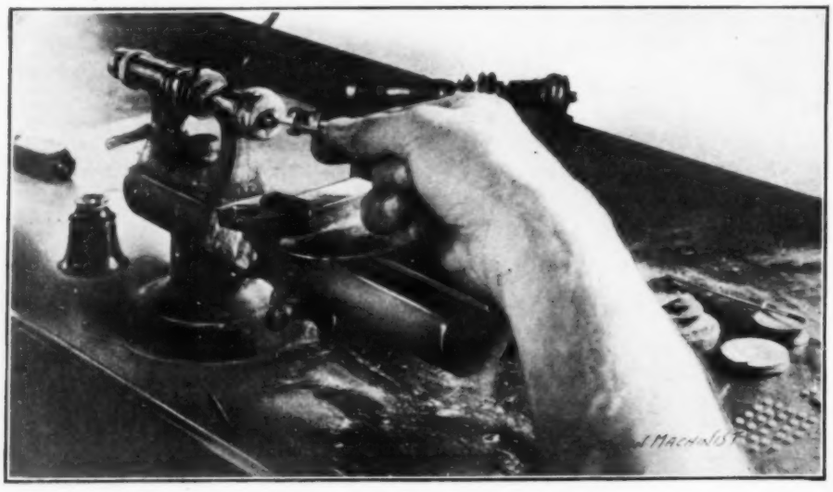


Fig. 9. Working Out the "Olived" Hole

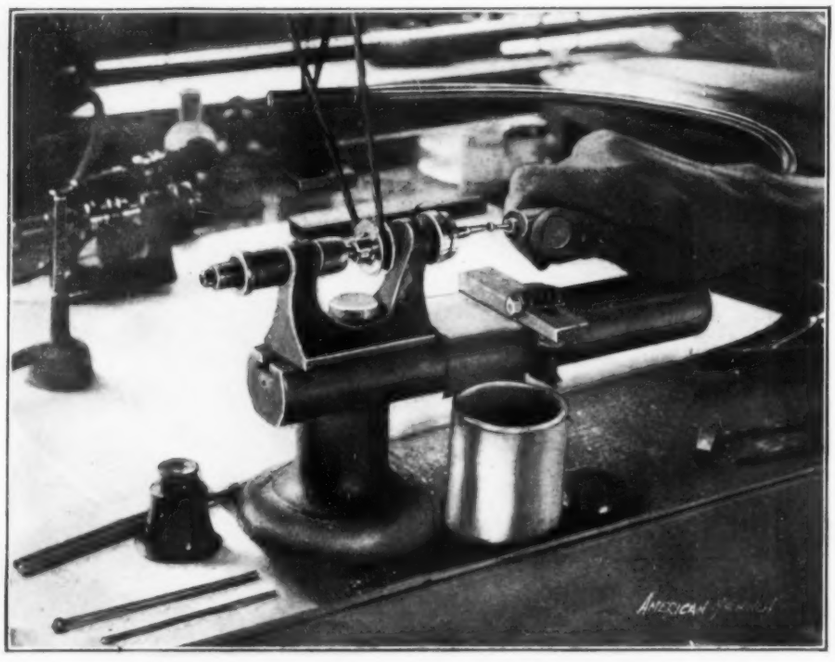


Fig. 10. Lapping Out a Jewel with Conical Hole

Following the drilling of the jewels, their faces are touched again with a small copper lap held in the hand.

Rapidity of Operations

One of the surprising features of jewel manufacture is the rapidity with which these sapphire bearings are produced. For example, ordinary sizes of jewels are regularly turned, drilled and polished at the rate of 80 to 100 in a day of ten hours. The holes in these jewels can be drilled and polished by one operator at the rate of 200 per day of ten hours. To the ordinary mechanic, at least, this seems like very rapid work upon such material. The production of some of the fine instrument jewels is, of course, less, 40 a day making a fair average. The polishing on these fine jewels consumes somewhat longer time, each one being microscopically inspected.

Fig. 11. Polishing Jewel Faces on Boxwood Lap

The usual range of watch jewel sizes runs from 1 to 3 millimeters outside diameter, the holes for the pivots ranging in the different sizes, say from 7/100 to 40/100 millimeters, or, from about 0.003 to 0.016 inch. Jewels are made for instruments and other purposes up to 10 millimeters diameter. A comparatively large jewel with olived hole for an instrument is shown at *L*, in Fig. 2. The central member of the group, *O*, is an ordinary end stone. A fairly good-sized jewel in its brass setting is shown at *R*.

Polishing End Stones

The photograph, Fig. 11, illustrates the boxwood lap which is used for polishing finally the faces of end stones, and jewels

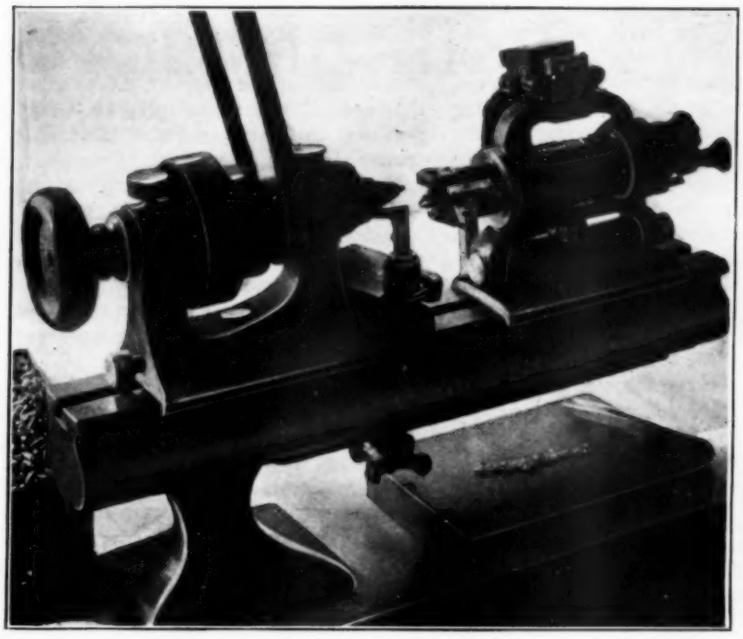


FIG. 13. A TURRET-JEWELLING REST

FIG. 14. TRUING UP SETTINGS BY THE JEWEL

with straight holes which are used with square-shoulder pivots and, therefore, require a finely finished bearing surface. In this operation the jewel is slipped into a seat in the end of the spindle facing the lap and is driven rapidly by the belt shown while pressed by a spring against the lap, which is coated with No. 5 diamond powder. The operator, with his finger in the leather loop around the spindle, draws the latter down, passing the work across the face of the lap while the spindle and work are drawn up again by spring action.

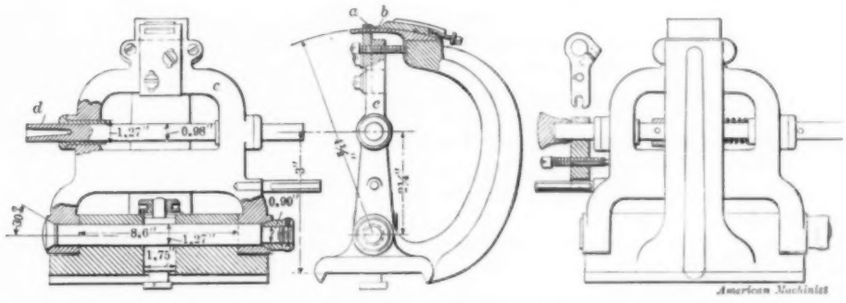


FIG. 12. AMES JEWELLING REST

JEWEL SETTING

As previously noted, some jewel settings are shown enlarged at *G*, Fig. 1, *K*, Fig. 2, and in the sectional view, Fig. 3. These settings are of brass, and the jewel is put in place in the bench lathe, with the aid of the Ames jeweling rest, a drawing of which is included in Fig. 12. The brass blank is placed in the draw-in chuck and the jewel to be set is placed between the jaws *a-b* of the swing rest, Fig. 12. The pivoted part of the rest *c*, carrying the boring and facing tool in holder *d* is swung up with its jaw *a* against the jewel, which, by its confinement between the two jaws of the rest, serves as a calibrating device for automatically setting the tool off center the

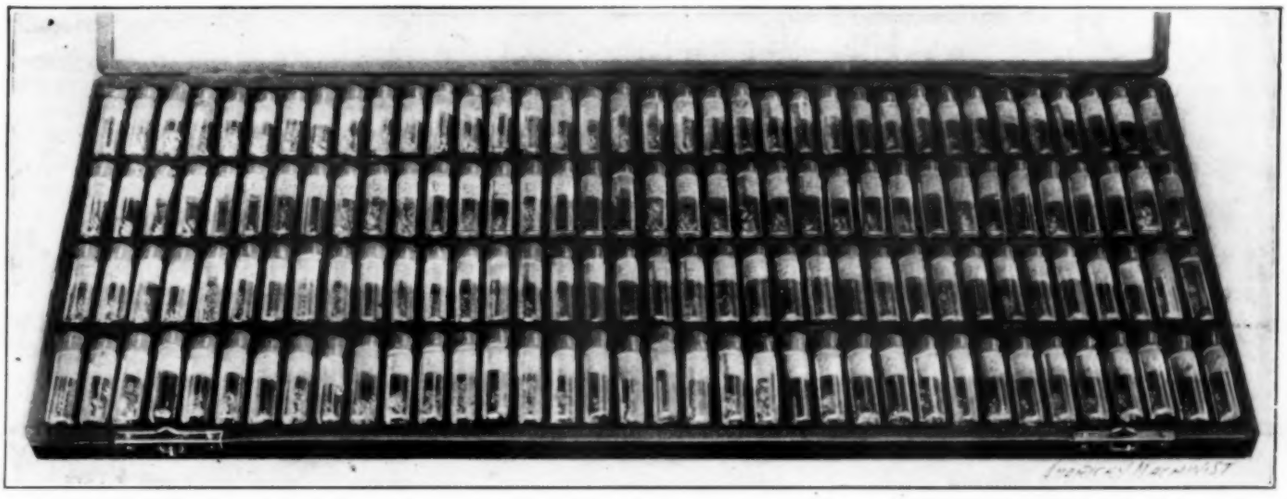


FIG. 15. A WATCH-JEWEL CASE

correct distance to bore the hole to a good fit for the jewel.

After the tool is run in to bore the hole and the end of the setting blank is faced the jewel is slipped in place, the hole being made slightly deeper than the thickness of the jewel to provide a few thousandths clearance above the jewel face. A hand burnishing tool is placed over the rest and pressed against the end of the brass setting, a slight distance away from the edge of the jewel. This cuts a shallow groove in the face of the brass piece, as indicated by Fig. 3, and spins the metal tight against the edge of the jewel, thus retaining it firmly in its seat.

This jewel, as well as the end stone, is set with the face slightly below the face of the brass setting, so that the two jewels when placed in the watch are kept apart sufficiently to prevent them from being broken. This clearance space is also shown exaggerated in the sectional view, Fig. 3.

A Turret Jeweling Rest

A new form of jeweling rest with a turret for carrying the tools is illustrated in Fig. 13, this being made for use on the Ames lathe. The turret has three tool holders and carries tools for boring and sizing the opening for receiving the jewel, facing the end of the setting and turning its outside diameter. The seat for the jewel is cut out by using the jewel itself as a setting device between the regular jaws at the top of the rest. The jaws may then be closed for the facing of the setting, which is accomplished with the turret indexed to the second position, and at the third position of the turret the rest is swung against an adjustable stop directly behind the turret which gives the correct position for the tool which turns the outside of the setting.

The method of feeding the tools to the work and indexing the turret, will be obvious upon inspection of the engraving.

Truing Up Settings from the Jewel

In many cases the jewel settings are finally trued up on the outside from the hole in the jewel itself. This is accomplished by cementing the setting to the end of an arbor as in Fig. 14, and, before the cement has hardened, truing the work with the aid of the "tell-tale" held in the right hand with its point entering the bearing in the jewel and its outer end resting against the base of the palm of the hand. The "tell-tale" pivots in a support near the jewel and the slightest inaccuracy in the running truth of the jewel is detected readily by the action of the "tell-tale heel" pressing against the hand. This device enables the operator to center the jewel setting accurately by the hole in an instant, and the side rest with its turning tools is then run forward to turn the setting to exact diameter and perfectly concentric with the jewel hole.

When the gas flame is applied to the cement by which the jewel is attached to the arbor, the setting may be instantly removed and another mounted in its place.

An interesting view is presented in Fig. 15, which shows a large case filled with small vials containing different sizes of jewels in their settings, for all of the well known makes of American watches. While these glass receptacles are not over an inch and a half high, each will hold about two thousand unset jewels, or about a gross of the average size of settings.

New Forse Mechanical Speedometer

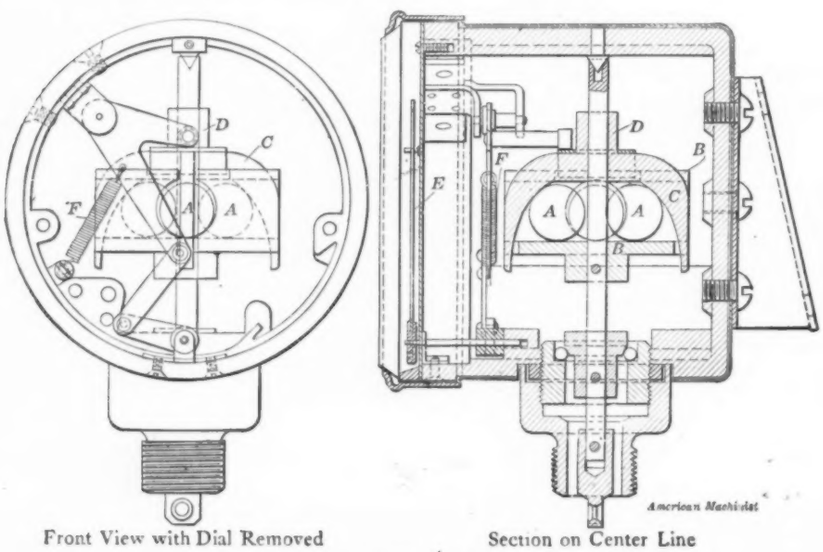
The line cut shows the ingenious way in which centrifugal force is utilized, in the Forse speedometer made by the Forse Manufacturing Company, Anderson, Ind., to indicate the speed of automobiles.

The centrifugal element consists of four ½-inch hardened steel balls *A*. These are confined in a cage *B* mounted on a vertical spindle, which cage consists of two cylindrical raceways at right angles to each other and the spindle. The tendency of the four balls to roll out from the spindle when it and the cage are rotated is resisted by a four-armed spider *C* whose curved arms are inserted in radial slots cut in the top of the cage. The inner edges of the arms of this spider rest upon the balls. The hub *D* of the spider slides freely on the spindle, and is connected by simple linkage mechanism to the indicating hand *E*. A single helical closed spring *F* resists the action of the balls on the spider, holding the latter down and the balls in against the spindle when at rest.

The curve of the inner edge of the arms of the spider *C* is such as to produce equal angles of motion of the indicating hand for equal increments of speed.

Calculation showed that the curve would partake of the characteristics of a parabola, since the centrifugal force exerted by the balls is proportional to the square of the linear velocity, while the resistance of the spring is proportional simply to the axial displacement of the spider. An experimental instrument having a spider with parabolic arms was made. This was subjected to careful tests from which slight corrections were made by filing the curve of the arms until correct action of the indicating hand was obtained. This corrected curve was then used in making the dies in which the spider is cast for the commercial instrument.

When the spindle is rotated at varying speeds, the action of the balls is a combined rolling and sliding. At low speeds the balls probably roll on the bottom of the raceways and slide on the arms of the spider in response to changes of speed. At high speeds when the pressure of the balls becomes greater on the spider, and the inclination of the arms is decreased as the balls bear further down on the parabola, the balls probably roll on the spider and slide on the bottom of the raceway. The instrument is sensitive to slight changes in speed throughout its entire range, from three or four to sixty miles per hour as it is geared for automobile use.



Front View with Dial Removed — Section on Center Line

A Mechanical Speedometer

Obtaining the Co-operation of Men

By H. F. J. Porter*

Some of the fundamental principles of co-operation between the management and employees if success is to be obtained.

The evolution of management of labor in industrial establishments similar to that of political government.

The committee system in industrial management.

*Industrial engineer, New York City.

When two sets of men have a common interest, when they are working together with the same ultimate purpose, it is not only desirable but necessary for them to coöperate if their interest is to be conserved or their purpose furthered. But this coöperation is not always an easy matter to bring about. One set of men or the other, or perhaps both, hold back because they either do not know how to get together or because each is unwilling to take the first steps, so if something practical is to be accomplished, they have to be shown sometimes that they are not coöperating at all and again that their coöperation is not as effective as it would be if the yielding of some comparatively trivial point at issue could be brought about.

In fact, mutual yielding in nonessentials must be brought about if actual coöperation is to be established.

Let me give a common instance of this as an illustration. One set of people walks daily on our sidewalks in one direction and another set walks in the opposite direction, while both sets have in mind the common purpose to use the same sidewalk, by which to reach their respective destinations. At first it might seem that these mens' interests were antagonistic, and it becomes evident that unless there is a natural recognition of each other's rights, constant collisions might occur and so much opposition be made to each other's progress that neither set of people could accomplish its purpose satisfactorily. Until recently the situation was different, the sidewalks were amply wide for all the people without friction. They knew one another and stopped to talk and all had plenty of time, but the growth of cities, with their consequent congestion of population, has brought about the necessity of conforming to predetermined customs and each person, instead of going in an absolutely straight line, recognizes the advantage of yielding a little and yet on special occasions even now it becomes necessary for some expert experienced in handling crowds to assume direction in order to enforce the custom.

It is only of late that this mutual yielding has been carried a step farther and has been brought about in the streets with traffic regulation to make continuity of vehicular motion in our large cities possible. It can be seen how, under present conditions, without some such system as has been devised our streets would become a menace to the peace of the community.

Purposes Are Identical

Now take two others sets of men, the management and employees in an industrial enterprise, both are using the latter as a common means of attaining their ends, viz., to make money. At first it would seem as if the purposes of these men were necessarily antagonistic, one set seeking to obtain from the other the greatest amount of work in return for the least amount of money, and the other set wanting to get the largest amount of money for the least amount of work.

When shops were smaller, the management knew all the men and they had plenty of time and all worked together in a common interest with the best of feeling, but the enormous growth in size of individual enterprises has made the management and employee strangers. And owing to the congested conditions of industry and the fact that no one has convinced them that their purposes are identical and that by proper coöperation they can reach their respective destinations satisfactorily, they have allowed conditions to become strained and often acute.

It is here that the specialist familiar with modern business methods can introduce the principles of practical coöperation, which will enable the management to secure the largest possible output of product and the employee to obtain the highest possible wage, while the company, the common means whereby both sets of men attain their ultimate object, serves both parties most efficiently and becomes a blessing rather than a curse in the community.

Schools Teach Business Administration

It is only proper that the technical school, which was in a large degree the cause of the wonderful advance in industry which has taken place during the past half century, should at last recognize some responsibility for the industrial strife which has come about through this advance. It has set itself the task of applying a remedy by establishing courses in business administration and thus supply to industrial enterprises managers equipped with information as to the best methods of bringing about coöperation between the two sets of men whose interests, though apparently antagonistic, are known to be identical.

The principles underlying these methods are fundamental, but the ways of applying them are as varied as there are industrial establishments, no two plants being constituted the same, and the conditions under which they operate being widely different.

In the first place, we have the two sets of men—the management and the employee. The management represents capital and the employee labor. Capital represents something tangible which the management is willing to exchange for something intangible in the shape of skill in the possession of labor.

In the tangibility of the asset which one set of men contributes to the make up of a company, and the intangibility of the asset which the other contributes, lies the cause for the inability of adjustment to a common measure of value. Capital reasons that it risks all it has which, if lost, cannot be redeemed, and asserts that the other side risks nothing, for it merely rents its skill. For these reasons capital claims that it must dictate the terms of risking its assets so as to control the responsibility for its own actions.

Labor recognizes the logic of this argument, but says it must secure a fair rental for its skill, for there is but one life in this world to enjoy, there is an age limit to the working term of that life and as that term is short at its end it must have acquired sufficient means to furnish the ability to enjoy what is left of life. Labor says also that to rent its skill at its highest efficiency it must minimize depreciation and that to keep up its repairs it needs certain facilities which capital must recognize its obligation to supply.

There is no disagreement so far in the theories of both sides. It is only when these theories are put into practice that the characteristics of the various personalities entering into the arrangements assert themselves and disagreements arise.

At this point industrial management simmers down to the question of the government of one set of men by another set.

Now government is an institution as old as man and we have only to look back over the history of its evolution to see how it has changed from the patriarchal to the absolute monarchic type, and then gradually through oligarchy or control of the few to democracy or self-government.

It is easy to show that the government of men is the same in principle whether few or many are involved, that the government of a nation, a state, a municipality does not differ from that of a smaller group of men as an industrial establishment. In fact many industrial

establishments are larger than good sized municipalities. Human nature is the element to be considered in all of them and it is the same in the small as in the large group.

We have only to look at the history of the management of industrial establishments to recognize the same evolution at work and to see that it has paralleled that of political government.

First we had the patriarchal-tribal type where the employer knew all his men and worked with them as a master workman. Then came the monarchic type or autocratic one-man control, and as the size of shops grew, the management grew in numbers to a type of oligarchy. None of these kinds of government has been successful in eliminating the unrest of the governed, for the latter have no opportunity to express their needs, and having no vent their feelings expand until their patience gives away and there has to be a readjustment, which lasts only for another period.

The Committee System

The tendency is toward democracy and it is the strongest in this country where all men are taught that they are free, but are by no means so during the greater number of their waking hours. Each industrial establishment is a relic of fuedalism. The nonrepresentative control of the employee is an anachronism in the Twentieth century.

Whenever democratic or representative management has been tried it has succeeded beyond the anticipations of the most sanguine. And this is because it allows the forces which through all the ages have made for progress, to have full play.

This is form of management known generally as the committee system. This system finds its parallel in the form of political government established in this country. It is installed as follows: The employees elect their "works committee" from among their own element. This body may be compared with the lower house of Congress. The management forms an advisory board of the foremen and heads of departments. This finds its prototype in the Senate. The works committee considers subjects referred to it through a "suggestion system," which is open to every individual in the organization. Each subject, after being acted upon by the works committee, is passed on to the advisory board, which makes recommendations regarding its acceptance or rejection to the management. The latter is comparable to the President and his cabinet, which has the approval or veto of all measures. All accepted suggestions are paid for, and the foreman from whose department the greatest number are accepted each month or each quarter-year is given a remuneration.

Bulletin boards, on which are posted the suggestions and the action of the committees on them, take the place of the newspaper and give publicity to every move that is made and help to establish public opinion. Frequent meetings held in the shops, at which are present representatives of the management, give an opportunity for a discussion of matters of common interest and allow the men a vent to express their thoughts and feelings freely. Thus the management can keep its hand on the pulse of the working organization and treat any symptom of an unusual condition before it develops to an acute stage. It is here where the policy of yielding in nonessentials and the standing up for fundamentals has its full play. All hands soon learn that the object of the system is to search for, find and develop the truth and that which is right, and with equal vigor discover and eliminate that which is wrong.

Democratic Form of Government

It can be seen that this system closely resembles the form of democratic government of the nation, which has evolved from the older monarchic form, and it proves to be as far ahead of the older one-man type of management in the shop as democracy is superior to absolute monarchy.

Of course, each accepted recommendation must be referred to the estimating and planning department for a report upon the cost of installing and maintaining the suggested improvement, together with the value of the resultant benefit. This is a very important detail in the system, but need be only mentioned in passing. But it brings us to the statement that all uptodate factories must have their organization properly subdivided into the various departments necessary for the carrying out of certain essential functions. Too frequently we find business houses running without having any departments at all, or without those they have being well defined, and their officers' duties consequently overlap. Under such circumstances subordinates do not know who are their superiors, and the latter cannot be held responsible for results.

It is just as if several shafts operating at different speeds were running through a machine shop and belts from all of them were connected with each machine and sometimes one shaft would start up and run a machine, or perhaps two would get active at the same time. The workman would undoubtedly become confused and his work would be most unsatisfactory.

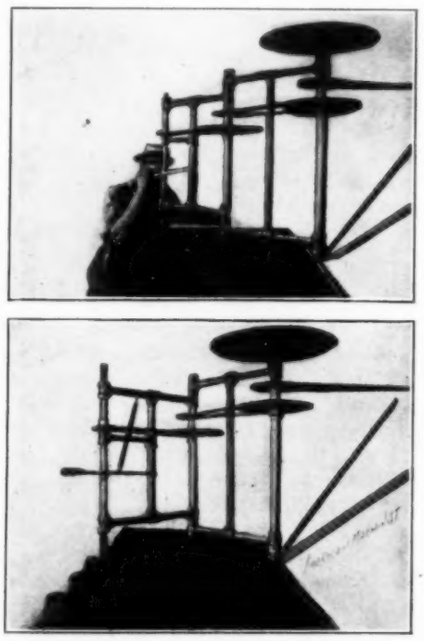
This means that a chart of organization should be drawn up showing the various departments, and who is in charge of each and the relations of one to another. In this way it can be seen at a glance where authority and responsibility are defined. It is as important to have this chart drawn up in advance, and changed as modifications in the shop are made as it is to have a layout of the shafting and all changes which take place thereafter recorded upon it.

When an employee is afforded an opportunity to purchase stock in the enterprise so as to share in the vicissitudes of the business, then his vital interests are enlisted, he becomes a partner in the business and he works hand in hand with the employer. This is coöperation that coöperates. It is obtained by allowing the forces which are strongest in human nature to have full play.

A Hinged Suspended Drill

By F. Patchett

The accompanying halftone illustrates two positions of the suspension drill that I made to drill some 30x72-inch brass plates, a number 55 drill. The holes were only about ¾ inch apart, and there were 3441.



Suspension Drill in Two Different Positions

This was a tedious job until I made the drill as shown. It is made up of 1-inch cold-rolled steel. One piece is suspended from a flange that is bolted to the ceiling. It is braced from the lower end with two braces, at slight angle to each other. A hinged frame is fastened to this suspended piece and this carries a ⅝-inch spindle, which swings over the plate to be drilled.

Compressed air velocity in shop mains should be below 2000 ft. per minute. Volume = free air consumption ÷ compressions (6.5 for 80 pounds; 8 for 100 pounds). Velocity = volume ÷ pipe area (square feet).

Automobile Engine Proportions—III

By A. G. Kessler
and G. W. Lewis

Cylinder construction, percentage of clearance volume, and compression pressure. Location, diameter and lift of inlet and discharge valves. Valve springs, closing force required, diameter of coils and wire. Valve timing to take advantage of inertia of gas flow.

Cylinder Construction

According to the arrangement of automobile-engine valves, cylinders of the four-cycle type may be classified approximately as follows:

(*a*) L-head cylinders; both valves in one pocket at side of cylinder.

(*b*) T-head cylinders; each valve in a pocket, on opposite sides of the cylinder.

(*c*) Plain cylinders; with valves directly in the head, placed either vertically, or at an angle.

(*d*) This class is really a combination of classes (*a*) and (*c*), generally having the inlet valve directly in the cylinder head, and the exhaust valve in a side pocket as in the case of T- or L-head cylinders, or *vice versa*.

From the cars exhibited at the various automobile shows, it has generally been found that the cheaper grade of machines use the L-head cylinder, while the more expensive cars use the T-head and cylinder with valves in the head, as explained under classes (*c*) and (*d*) above. The construction of types coming under classes (*b*), (*c*) and (*d*) is in general more costly than is the L-head cylinder, and also somewhat more complicated. Whether the gain in mechanical and thermal efficiency warrants the use of the former is a matter to be determined by individual comparative tests, no definite information being available on this point.

In laying out cylinders on the drafting board one of the first items that naturally occurs to the designer is "What will be the overall bearing length"; the cylinder bearing length being that part of the cylinder touched by the extreme points of the piston in its travel over an entire stroke. The cylinder bearing length is obviously equal to the length of stroke plus piston length, minus the overtravel at the head and crank ends.

The stroke and piston length have been previously determined. The overtravel at the head end depends somewhat upon the design of the piston face, cylinder head and location of the first piston ring on the piston barrel. In designs where the first ring is placed very near the head of the piston, this ring is allowed to overtravel the cylinder counterbore to the center of the first ring, and thus prevent the wearing of a shoulder in the cylinder wall. In general, however, this amount of overtravel may be said to vary from 0 to 5/16 inch, with an average of about ¼ inch. The overtravel at the crank end is somewhat greater than at the head end, and was found to vary between 0 and 1 inch, with a good average of ½ inch. It will be noted that the greater the amount of overtravel, the shorter can the cylinder be made, thus gaining head room to a certain extent. Consequently, the bearing length of the cylinder, or the length between counterbores may, for the average case, be taken equal to length of stroke plus piston length, minus approximately ¾ inch.

Cylinder Wall Thickness

The next item that must be determined is the thickness of cylinder wall, and for this purpose the way in which cylinders are most liable to rupture must be considered. It has been found that rupture is most apt to occur along the axis of the cylinder and that if the cylinder is safe in this plane, it is amply safe in other planes.

In Fig. 1 is shown a section of a cylinder one inch in length along the cylinder axis. The bursting tendency produced along a 1-inch element of the cylinder due to the maximum explosion pressure is; $P_m \times D \times 1$ inch, tending to split the cylinder into two semicircular halves.

This is resisted by the two walls along one inch of cylinder length, and the stress per square inch of metal at the instant of maximum explosion is therefore obtained from;

$$D \times 1'' \times P_m = S_t \times 2\,(T_{cyl.} \times 1'')$$

from which

$$T_{cyl.} = \frac{P_m D}{2 S_t} \text{ or } S_t = \frac{P_m D}{2 T_{cyl.}}.$$

The symbols have the following meaning:

D = Cylinder diameter in inches.
P_m = Maximum explosion pressure in pounds per square inch.
S_t = Allowable fiber stress in pounds per square inch.
$T_{cyl.}$ = Thickness cylinder wall in inches.

From practice, cylinder wall thicknesses were found to vary between 3/16 inch and 5/16 inch, with an average of ¼ inch for all cylinder diameters. By substituting the average value of ¼ inch in the equation just developed, it will be found that, for a maximum explosion pressure of 350 pounds, the fiber stresses vary between 2800 and 3500 pounds per square inch for all cylinder sizes at present on the market.

Width of Jacket Space

The width of jacket space was found to vary between 7/16 inch and ¾ inch, and a good average may be determined from the equation

$$W_j = 0.6875 - 0.0375\,D \text{ inches},$$

in which

W_j = Width of jacket space in inches;
D = Cylinder diameter in inches.

Inspection of the equation just given may, at first sight, lead one astray, for it will be found that the width of jacket decreases slightly as the cylinder diameter increases. However, if the circumferential area of the jacket space be

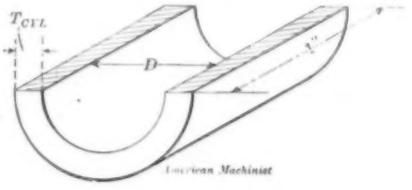


Fig. 1. Bursting a Cylinder

considered, it will be found that this area increases slightly as the cylinder diameter increases, and consequently the total volume of water surrounding the cylinder increases with the cylinder diameter.

The question of how far the jacket should extend down the cylinder is readily settled, this being near the lowest position occupied by the piston head or face (when the piston is on the lower or crank end dead center). To extend the jacket further simply increases the total engine weight without adding any material gain to the cooling effects. It is, however, necessary to run the jacket thus far to insure proper cooling and prevent any danger from overheating the engine.

Thickness of Jacket Walls

Next in order comes the determination of the thickness of jacket walls. In automobile practice these walls are made as thin as possible to increase the radiation and keep down the engine weight. They merely are made thick enough to be consistent with strength, stiffness and good casting. The thickness of jacket walls was found to vary between ⅛ inch and 3/16 inch, with a good average for all cylinder diameters of 5/32 inch.

Sheet-metal jackets are used on a few automobile motors, but the cast jacket is by far the most common in automobile work. The thickness of sheet-metal jackets varies between 1/32 and 1/16 inch.

Cylinder Head Thickness

Automobile cylinder heads are made in

such various ways that to give a general method of checking is well nigh impossible. They also contain numerous openings and are of such variable shape that theoretical checks are of little value, and empirical design is generally relied upon.

Practice shows that in the average case the cylinder head is made but slightly thicker than the cylinder wall, the increase over the cylinder wall thickness varying between 1/32 and 3/32 inch. In many cases also the head and wall are made of equal thickness.

The design of the cylinder head involves other important items which, to a great extent, determine the horsepower output of the motors. Among these are the cylinder clearance and compression pressure, which will, therefore, be considered next.

Cylinder Clearance and Compression

When the piston is on the upper or head end dead center, with all valves closed, the volume inclosed in the cylinder head and valve pockets is known as the clearance volume of the cylinder. This volume, divided by the volume displaced by the piston per stroke in like units, gives the proportion of clearance volume relative to piston displacement. Engines as built at present have clearance volumes ranging from 20 to 33 per cent. of the piston displacement, with an average of about 25 per cent. The amount of clearance is the most important factor in determining the value of the compression pressure and, as the latter has been increased considerably during the past few years, the clearance volume has been correspondingly decreased to produce this result. Compression pressures at present range between 60 and 85 pounds gage, with an average of 76 pounds.

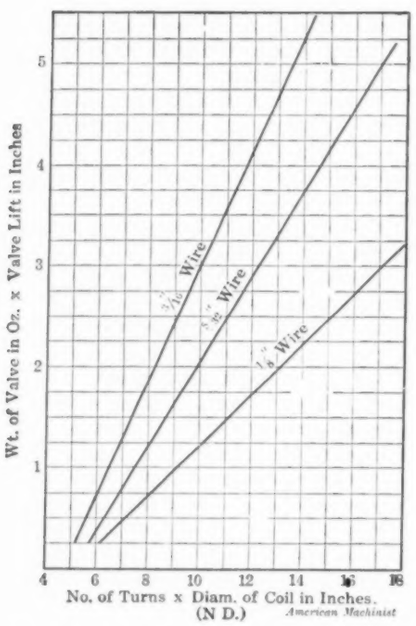


Fig. 2. Relations of Valves and Springs

To so design the cylinder head as to give the above values of clearance and compression, it may be best to give an idea of the average distance usually allowed between piston face and cylinder head when the piston is on the upper, or head end dead center. This item, of course, depends on many varying factors, such as type of cylinder, whether L-head or T-head; upon whether the piston face is arched or flat, and upon other innumerable items entering into the design of the combustion space. A general relation, however, for L-head and T-head cylinders, may be had from the following equation:

$$C_l = 0.241\ D - 0.13\ \textit{inches},$$

in which

C_l = Average clearance, or distance between cylinder head and piston face when the piston is on the upper or head end dead center (in inches).

D = Cylinder diameter in inches.

Location of Valves

The distance between center lines of valves and center line of cylinder is an item which, upon investigation, was found to be quite the same for both L-head and T-head cylinders; that is, for similar valve and cylinder diameters. The distance may be found from the equation:

$$X = 1.33\ D - 1.78\ \textit{inches},$$

in which

X = Distance in inches between valve and cylinder center lines.

D = Cylinder diameter in inches.

Valve Guides

These may be considered as a part of the cylinder construction or as a part of the valve gear. The writers have chosen to take them up as a part of the latter, and they will consequently be considered under the heading, "Valves."

Fastening of Cylinders to Crank Case

The lower, or crank end of the cylinder is bolted to the crank case, as a rule, so that at the instant of maximum explosion each cylinder is held fast to the case by four bolts, each taking one-quarter of the total maximum explosion load. On the basis of a maximum explosion pressure of 350 pounds per square inch, the stresses coming upon these bolts are in the neighborhood of 10,000 pounds per square inch. For this reason nickel-steel bolts, or studs, are commonly used in this capacity. The average size of these bolts is given in tabular form as follows:

Cylinder diameter, inches	3	4	5
Outside diameter of bolt, inches (standard bolt sizes)	3/8	1/2	5/8

The limits in sizes between which these bolts are used are from 3/8 to 5/8 inch, 1/2-inch bolts being by far the most common.

Flange at Bottom of Cylinder

To give a good bearing surface, and thus assist in keeping the cylinders in proper alinement, a flange is generally cast all around the lower end of the cylinder, varying in thickness from 7/16 to 9/16 inch, with an average for all cylinder diameters of 1/2 inch. At the points where the bolts run through this flange, the latter is usually widened out and made thicker in the form of a lug. The increase in thickness over that of the flange is about 1/4 inch for the average case. This makes the average thickness of such lugs from 5/8 to 3/4 inch, for practically all cylinder diameters.

Valves

Practically all automobile-engine valves are of the poppet type. Valve disks may be made of steel or of cast iron, but valve rods are always made of the former. When valve and disk are of steel, they usually form a single drop forging. Valves might be classed according to the shape of the valve disk, as; (*a*) flat seated, or flat valves; and (*b*) valves with angular seats, the seat generally being cut at 45 degrees with the valve-stem axis. The latter class is by far the more common type in present day use. Other angles than 45 degrees have also been used lately to some extent to give less noisy operation.

In a few motors the inlet and exhaust valves and valve lifts are made different, but common practice at present is to make valves interchangeable and the following discussion has been based upon this condition.

Valve Diameter, Inlet and Exhaust

During the past few years valve diameters have been greatly increased in proportion to cylinder diameters, this difference being particularly noticeable between 1909 and 1910 motors. For this reason it has been deemed advisable to give not only an average equation but also equations giving the upper and lower limits of present-day practice. The *average* valve diameter for any cylinder diameter may be found from

$$D_v = 0.5\ D - \tfrac{3}{8}\ \textit{inches},$$

in which

D_v = Valve diameter in inches.

D = Cylinder diameter in inches.

The *maximum* valve diameter for any cylinder diameter may be obtained from

$$D_v = 0.55\ D - 0.15\ \textit{inches}.$$

The *minimum* valve diameter may be found from

$$D_v = 0.66\ D - 1.66\ \textit{inches}.$$

It will be seen from the equations just given, that in some cases valve diameters are made even greater than half the cylinder diameter, this for ordinary motor construction being, however, not a common occurrence, except in a few of the latest designs.

Valve Lift, Inlet and Exhaust

As previously stated, valve lifts may be made slightly different, but in the majority of cases they are made alike for both inlet and exhaust. The following equation therefore applies to either case:

$$L_v = 0.095\ D_v + 0.155\ inches,$$

in which

L_v = Lift of valve in inches.
D_v = Diameter of valve in inches.

In automobile practice, valve lifts vary between ¼ and 7/16 inch, the average lift for any cylinder diameter being given by the above equation.

Gas Velocity through Inlet and Exhaust Valves

The quantity of gas passing through any valve opening is $Q = FV$ in which

Q = Quantity of gas passed per minute in cubic inches.
F = Area of port, or opening, in square inches.
V = Velocity in inches per minute.

Also, since the cylinder must be filled at each charging stroke, the quantity of gas passing through the valve port per minute is equal to

$$Q = \frac{\pi D^2}{4} \times L \times \frac{N}{2},$$

where

D = Cylinder diameter in inches,
L = Stroke in inches,
N = Revolutions per minute, for 1000 feet piston speed.

The area of the port, or opening through which the gas must pass is

$$F = \pi\ D_v L_v,$$

where

D_v = Diameter valve in inches,
L_v = Valve lift in inches,
F = Area of valve opening in square inches.

Then, since $Q = FV$

$$V = \frac{Q}{F} = \left(\frac{\pi D^2 L}{4} \times \frac{N}{2}\right) \div (\pi D_v L_v),$$

provided the flow is steady and continues during the entire minute. This is not the case, however. Since there is only one charging stroke during every two revolutions, or four strokes, the gas can flow only approximately one quarter of a minute for every minute of operation of the engine. Therefore, the real velocity will be four times that just calculated, or

$$V = \left(\frac{\pi D^2 L}{4} \times \frac{N}{2} \times 4\right) \div (\pi D_v L_v)$$

in inches per minute, or

$$V = \frac{D^2 L N}{24 D_v L_v}$$

in feet per minute.

Example

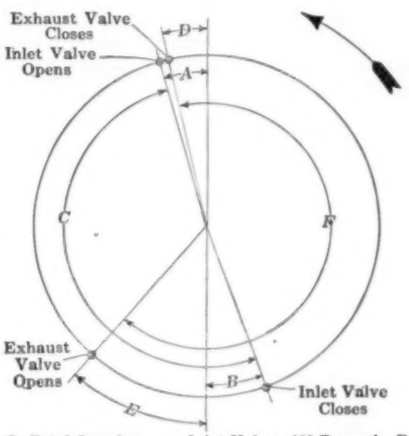
Take a motor with a 4¼-inch bore and a 4½-inch stroke. This will run at approximately 1330 revolutions per minute for a piston speed of 1000 feet per minute (or the speed at which the motor is rated, A. L. A. M. rating), and from equations just given the average valve diameter will be 1¾ inches, with valve lift of 5/16 inch.

Substituting in the equation just developed the following is arrived at

$$V = \frac{D^2 L N}{24 D_v L_v} = \frac{18.1 \times 4.5 \times 1330}{24 \times 1.75 \times \frac{5}{16}} = 8250$$

feet per minute or 137 feet per second.

From an average of a great number of such calculations it was found that the average gas velocity through both inlet and exhaust valves equals about 130 feet per second, when the motor is running at a piston speed of 1000 feet per minute. It was assumed here that the valves are open just one stroke, or 180 degrees of revolution. It will be shown later that actually both inlet and exhaust valves are open a somewhat greater time than this and consequently the gas velocity will be less than that just given, by a slight amount.



C = Total Opening — Inlet Valve = 180 Deg. − A + B
F = Total Opening — Exhaust Valve = 180 Deg. + D + E

Inlet Valve	Exhaust Valve
Average A = 14.7 Deg.	Average D = 10.3 Deg.
Average B = 35.4 Deg.	Average E = 45.3 Deg.
Average C = 200 Deg.	Average F = 236 Deg.

$A = D + 4$ Deg.

American Machinist

Fig. 3. Valve Timing for Four-cycle Engines

Another point which might be mentioned here is that the exhaust valve is generally open a greater length of time than the inlet valve, making the exhaust velocity somewhat less than the velocity through the inlet valve. These are refinements, however, which it was not deemed necessary to consider here, as they would greatly complicate matters and add but little to the accuracy of the work.

The preceding deals only with average gas velocities. Since for ordinary ratios of crank to connecting-rod length, the maximum piston speed is approximately 1.6 times the average, the maximum gas velocity will be about 1.6 times the average, or about 210 feet per second for usual motor design. In extreme cases the average velocity has been known to run as high as 225 feet per second, giving a maximum of about 360 feet, but such cases are rare and occur only with the use of valves very small in proportion to the cylinder diameter.

Valve Disk Thickness

The thickness of valve disks made of steel was found to vary between 3/16 and ⅜ inch, with an average for any cylinder diameter given by the following equation:

$$T_{vd} = \tfrac{1}{8}\ D_v + 0.03\ inches,$$

in which

T_{vd} = Thickness valve disk in inches.
D_v = Diameter valve in inches.

For cast-iron disks no values can be given as these are not very common and their types, when they do occur, are widely different in design.

Valve-stem Diameter

Valve-stem diameters can hardly be said to have a range of values, since all sizes come within the limits of ⅜ to ½ inch. An accurate average value may, however, be determined from the equation

$$D_{vs} = 0.094\ D_v + 0.226\ inches,$$

in which

D_{vs} = Diameter valve stem in inches.
D_v = Diameter valve in inches.

Length of Valve Stem

The length of valve stem depends more or less upon the general engine design, location of valves, cam shafts, etc. It was found, however, that for L-head and T-head cylinders, the average length of stem from bottom of valve disk to valve tappet rod is 6½ inches, varying between a maximum of about 8 inches, and a minimum of about 5¾ inches.

Valve-stem Guides

Valve-stem guides may be a part of the cylinder casting, or they may be separate bushings of bronze or steel. In the latter case they are fastened to the cylinder casting by a screwed joint and nut or kept from falling out of position simply by the force of the valve spring. The length of these guides is a function of the length of the valve stem, the longer the stem, the longer must be the guide to seat the valve properly and thus prevent uneven wear. The length of the valve guide is, therefore, given as a function of the length of valve stem.

$$L_{vg} = 0.97\ L_{vs} - 2\tfrac{1}{4}\ inches,$$

in which

L_{vg} = Length valve guide in inches.
L_{vs} = Length valve stem in inches (given above).

Weight of Valves

The approximate weight of valves (valve disks plus valve stems) for steel drop forgings only, is given by the equation

$$W_v = 2.03\ D_v^2 - 0.35\ ounces,$$

in which

W_v = Weight of valve in ounces.
D_v = Diameter of valve in inches.

Valve Springs

Poppet valves are of two classes, automatic or mechanical (positively operated). Both require springs, but since the majority of automobile engine valves are mechanical, only this class will be considered in the following discussion.

In the mechanically operated inlet valve, the spring must perform but one function, namely that of closing the valve in a given time. In the case of the exhaust valve the spring must perform a double function: (*a*) that of closing the valve in a given time and (*b*) that of keeping the valve closed against the suction in the engine cylinder. In either case the valves are operated by cams which must work against the pressure exerted by the spring.

The data received from the various manufacturers of automobile engines showed that the design of valve springs has not been brought to a rational basis. To design a valve spring is not such a difficult matter, but to be certain that the spring designed will operate satisfactorily is quite different. At present the majority of manufacturers use the "cut and try" method, using such springs as are found to give satisfactory results in operation, without particular reference to theoretical considerations.

As previously stated, the exhaust valve spring performs two functions, one of which is to keep the valve closed against suction pressure. The spring must, therefore, be placed under an initial load. The suction pressure exerted on the exhaust valve may be readily calculated. For example, on a 2-inch automobile valve, assuming a suction pressure of four pounds per square inch below atmosphere, the total suction load is found to be 12.5 pounds. This is merely the product of 4 by the area of a 2-inch circle in square inches.

The other force that the spring must exert is that necessary to overcome the accelerating force of the valve, and close it in the given or required time. From the following discussion it will be seen that this accelerating or inertia force is (a) directly proportional to the weight of the valve and to the hight of the valve opening (valve lift), and (b) inversely proportional to the square of the time during which the valve is open or "off its seat."

Let the valve be considered open, or off its seat, for θ degrees of crank angle and assume a speed of 1500 revolutions per minute. This speed was assumed since springs must operate satisfactorily at high speeds as well as at low, and as but few motors run over 1500, at least during ordinary operation, this is a reasonable value upon which to base calculations. The angular velocity is then equal to $360 \times 1500 = 540{,}000$ degrees of crank angle per minute. Now, if the valve be assumed as opening or closing during one-half the time that it is off its seat, then the time of opening or closing is $\frac{\theta}{2}$ degrees of revolution or $\frac{\theta}{2 \times 540{,}000}$ minutes $= \frac{\theta \times 60}{2 \times 540{,}000}$ seconds $= \frac{\theta}{18{,}000}$ seconds.

The valve must be started up, raised to a maximum velocity and stopped, in $\frac{\theta}{18{,}000}$ seconds. The time of increasing velocity is then approximately $\frac{\theta}{2 \times 18{,}000}$ seconds. At the time of maximum velocity, the valve (neglecting angularity) has lifted about one-half its total lift distance. Let the total lift be equal to L_v in inches. Then the valve is carried with assumed uniform acceleration from zero velocity to maximum velocity in $\frac{\theta}{2 \times 18{,}000}$ seconds, while the distance passed through equals $L_v/2$ inches, or $L_v/24$ feet. Now, for uniformly accelerated motion,

$V = at$

$S = \frac{1}{2} at^2$

in which

V = Velocity in feet per second;
a = Acceleration in feet per second, per second;
t = Time in seconds;
S = Distance passed through in feet.

Then

$$S = \frac{L_v}{24} \text{ and } t = \frac{\theta}{2 \times 18{,}000} = \frac{\theta}{36{,}000}.$$

Also

$$a = \frac{2S}{t^2} = \frac{2 \times \frac{L_v}{24}}{\frac{\theta^2}{36{,}000^2}} = \frac{2 L_v \times 36{,}000^2}{24 \theta^2}.$$

Or

$$a = \frac{108 \times 10^6 L_v}{\theta^2}.$$

Now, force = mass × acceleration = $\frac{Wt.}{32.2} \times$ acceleration.

so

$$Force = \frac{Wt.}{32.2} \times \frac{108 \times 10^6 \times L_v}{\theta^2} = \frac{Wt. \times L_v \times 10^7}{\theta^2 \times 3},$$

where

Wt = Weight of valve in pounds;
L_v = Lift of valve in inches;
θ = Angle of crank rotation in degrees during time valve is open or "off its seat."

The preceding formula can be applied equally well to inlet and exhaust valves by merely substituting the proper values. A typical example of its application is given in the next paragraph.

Example of Valve Closing Force

Assume the diameter of an exhaust valve to be 2 inches. From preceding equations such a valve will be found to weigh 8 ounces, or ½ pound. Also assume the valve lift to be ⅜ inch. The average total opening of exhaust valves as found from practice equals 236 degrees of crank angle = θ. (See Valve Timing.) Then from the equation just developed, the force necessary to close the valve in the time required can be calculated as follows:

$$Force = \frac{Wt. \times L_v \times 10^7}{\theta^2 \times 3} = \frac{\frac{1}{2} \times \frac{3}{8} \times 10^7}{(236)^2 \times 3} = 11\tfrac{1}{4} \text{ lbs.}$$

From the data received the diameter and lift of valves with corresponding valve spring dimensions were obtained. In order to use these data to the best possible advantage it was assumed: (a) That the strength of the spring is a function of the total length of wire in the spring and the diameter of the wire. Also that the weight of valve times its lift is a function of the accelerating force and consequently also a function of the spring strength. In other words, the product (weight of valve in ounces times valve lift in inches) is proportional to (number of turns times diameter of coil in inches). Consequently these two items were plotted against one another and the results obtained for various wire sizes are shown in Fig. 2. It was found that there were three separate and distinct groups through which average lines could be drawn, as shown in the line cut.

The diameter of coils and the number of turns depend somewhat upon the head room to receive the spring. In the following table the averages obtained from practice are shown:

Diameter of Wire.	$\frac{1}{8}$"	$\frac{5}{32}$"	$\frac{3}{16}$"
No. of turns.....	12	11	10
Diam. of coil.....	$1\frac{7}{16}$"	$1\frac{3}{8}$"	$1\frac{1}{4}$"

Here diameter of coil is measured to center of wire.

Example of Spring Selection

How to make use of the preceding material is best and most simply shown by working out a typical example as found in practice.

Assume a valve diameter = 2¼ inches.

Assume a valve lift = ⅜ inch.

From the equation previously given, the weight of a 2¼-inch valve is found to be 10 ounces. Then, referring to Fig. 2, the product of valve weight in ounces times valve lift in inches = $10 \times \frac{3}{8} = 3.75$, gives the abscissa for the set of curves there shown. Running horizontally across on the 3.75 line, the values of the product (number of turns times diameter of coil in inches) can be obtained

for three wire sizes there given. They are as follows:

For $\frac{5}{16}$-inch wire the product $ND = 11.3$.
For $\frac{3}{8}$-inch wire the product $ND = 14.0$.
For $\frac{1}{2}$-inch wire the product $ND = 20.0$.

From the table of wire sizes, number of turns and coil diameter just given, we find that for 3/16-inch wire the average number of turns used is 10. Then, $ND/N = D$ or $11.3/10 = 1.13$ or a $1\frac{1}{8}$-inch diameter of coil. The spring specifications would then be: Ten coils of 3/16-inch wire, with a coil diameter of $1\frac{1}{8}$ inches. But from the table it immediately will be seen that for 3/16-inch wire, a coil of only $1\frac{1}{8}$ inch diameter is rather small. Therefore, it may be best to use but nine turns instead of 10, thus increasing the coil diameter so as to make it more nearly conform to average practice.

Then, $ND/N = D = 11.3/9 = 1.25$ inch diameter of coil. The wire then to be used consists of nine turns of 3/16-inch wire with a coil diameter of $1\frac{1}{4}$ inches. In a similar manner the dimensions for the other wire sizes given may be calculated, giving results which are averages from present-day practice.

Valve Timing. Timing of Inlet Valve

When the mixture is admitted to the engine cylinder and the motor is running at normal speed, the velocity of gas through the inlet valves assumes (for average conditions) a maximum velocity in the neighborhood of 13,000 feet per minute, or even more. Now, if the inlet valve were closed on the lower or crank-end dead center, the momentum or inertia of the gas column would force the gas (or mixture) against the closed valve with an increasing pressure for an instant, and then the excess pressure would be relieved by a flow of mixture back into the manifold.

To take advantage of the inertia of the gas column at the point where it is most effective in bringing mixture into the cylinder (which point is very near the crank or lower dead center), the inlet valve is not closed until sometime after the piston has passed the crank or lower dead center, and is returning for the compression stroke. This point is generally determined by trial when the engine gives its maximum horsepower at a specified speed, and is evidently the point where the cylinder has received the maximum amount of explosive mixture. It was found that in present-day practice the inlet valve is closed from 15 to 40 degrees late (past crank-end dead center), with an average for all cases of about 35 degrees. Fig. 3 shows the valve timing as an average of present automobile practice.

It might also be stated that the point of closing the inlet valve may be defined as that point where the compression caused by the piston beginning the upstroke (toward the head end) is just balanced by the inertia of the gas column of incoming charge through the inlet valve.

The opening of the inlet valve follows closely after the closing of the exhaust valve, and the time of opening this valve will therefore be given after the closing of the exhaust has been discussed.

Exhaust Valve Timing

Common practice shows that the exhaust valve opens before the lower or crank-end dead center is reached. The pressure drop during the first half of the explosion or power stroke is very great but during the latter half of this stroke the pressure drop is at a constantly decreasing rate, and the power obtained or lost near the end of the explosion stroke is of little consequence. Therefore, it has been found that by opening the exhaust valve from 30 to 60 degrees ahead of the lower or crank-end dead center (average about 45 degrees; see Fig. 3), the cylinder can be freed of a great amount of very hot and more or less ineffective material, so that when the piston reaches the crank-end dead center it has merely to exhaust the remaining charge at a pressure but slightly above atmospheric, thus entailing only a small loss of power on this pumping stroke.

The gas, on passing through the exhaust valve, is also given a certain momentum by the moving piston behind it (similar to that explained under Inlet Valve Timing) and advantage is also taken of this fact to aid in further clearing the cylinder of the burned charge. For this reason the exhaust valve is made to close from 0 to 18 degrees late (after the upper, or head-end dead center, has been passed), average conditions prescribing a late closing of the exhaust valve equal to 10 degrees. See Fig. 3.

Opening of the Inlet Valve

The opening of the inlet valve follows immediately after the closing of the exhaust, thus preventing any danger of blowing the incoming charge out through the exhaust with the usual attendant troubles. Average conditions give an inlet valve opening of approximately four degrees after the exhaust closing. This means that in the average case the inlet opens between 14 and 15 degrees after the upper, or head-end dead center has been passed.

Total Opening of Inlet and Exhaust Valves

Present practice shows that the total opening of inlet valves varies between 185 and 205 degrees, with an average of 200 degrees of crank angle. See Fig. 3.

Total opening of exhaust valves varies between 223 and 245 degrees, with a good average of 236 degrees.

Some Costs of Driving Machine Tools

By John R. Godfrey

I was in a shop not so very long ago that had been modernized to the extent of adopting electric motors for all its larger machines and had group driving for the smaller ones. They had become convinced of the out-of-dateness of any other method and had called in an expert electrical engineer to do the job up in proper shape for them.

They had been assured of a great saving in power due to the elimination of belts and shafting and the fact that you only used power when the machine was running, which is undoubtedly true. But the shafting proposition did not seem to pan out quite so decidedly as they had imagined.

After the generators and motors had been installed according to the plans and under the direction of the aforesaid engineer, the main belt was thrown off the line shafting and the same engine turned its attention to running the generators.

But in spite of the saving from not running the shafting, the engine absolutely refused to drive the shop by the new method. It was probably pure cussedness on the part of the engine, but the fact remained that it could not be induced to run the whole shop with the aid of the generators and the motors.

Skeptics as to the new method were unscientific enough to suggest that the loss in generators, wires and motors was heavier than with the belting and shafting, but the electrical engineer promptly disproved that with charts, diagrams and other things equally convincing—to everything but the engine. That remained stubborn and refused to turn over with the full load of the shop.

Cutting out a few large machines or cutting out some of the groups allowed the old engine to do business as before, but it was necessary to put in a larger engine before the whole plant could be run with the new system.

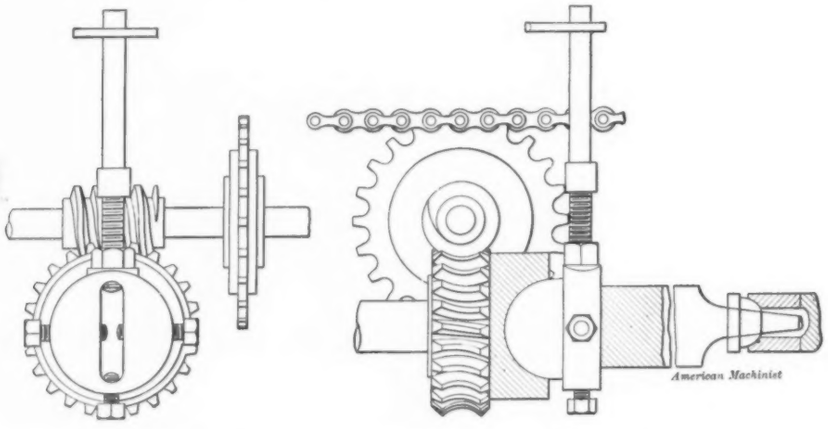
And the manager is still trying to figure out where his new equipment is any more economical than the old way, when he counts the cost of the new engine, the generators, the motors and all the rest. Of course, he knows it must be because he has the engineer's authority for the fact, but all the directors are not entirely satisfied and the dividends have not increased to the point where they are likely to be curbed by special statute.

Machine Testing of Files

Editorial Correspondence

Description of an addition to the Herbert file-testing machine by which the file is given a slight sidewise movement. The results are much more concordant.

Prof. W. Ripper, of the Applied Science Section, Sheffield University, criticized the Herbert file-testing machine and some of its results on the occasion recently of the Sheffield meeting of the British Association for the Advancement of Science. His paper is here given in abstract. He said that very early in the history of the machine, doubts were entertained as to the accuracy of its results. Files considered to be of the very best quality gave very poor results, great differences of cutting power were reported between files supposed to be in all respects alike, and differences between the two sides of one and the same file, varying from 4 to 1 or more, were said to be common, even among the best makes. Eventually Professor Ripper was asked to examine and report on the machine. The makers, E. G. Herbert & Co., Manchester, placed a new machine at his disposal for the purpose, and samples of files were also supplied for test by several leading Sheffield houses. The results of these tests were in many cases normal, but in many other cases extraordinary differences of effectiveness of cutting power were found to exist, both between files of the same batch and between the opposite sides of the same file.



PROFESSOR RIPPER'S ADDITION TO THE FILE TESTING MACHINE

THE NEW FEATURE DESCRIBED

The file is a cutting tool. At the beginning of a test it is sharp. As the test proceeds the file becomes blunter and blunter, but the weight on the file per square inch is constant. It therefore would seem to be obvious that when the sharpness of the file disappears the rate of cutting would begin to fall off and be shown by a curve more and more sloping to the horizontal. It is almost inconceivable that such a tool should retain its sharpness to the very end of the test and finally absolutely break down. In the machine the file moves across the face of the test bar through an absolutely constant path, the respective teeth of the file working in identically the same grooves or furrows on the face of the test bar, stroke after stroke. The result is that the face of the work occasionally becomes glazed in appearance, and the file ceases to cut, though it may not be worn out. In the case of hand files no two strokes are made exactly in the same direction. The conditions, therefore, under which the tests are made in the machine differ from those under which the file is worked in actual practice, and this difference works to the disadvantage of the file.

In order to more nearly approach the conditions of hand filing, Professor Ripper devised an addition to the Herbert machine by means of which the path of the file slightly changes, stroke by stroke, as in the case of hand filing. To secure this, the file is not held rigidly at its two ends, but is connected by ball joints, the effect of which is equivalent to that of a wrist movement at each end of the file. The variation of the path of the file is obtained by slightly shifting the position of one end of the file relatively to the other end by a simple mechanism secured to the reciprocating headstock. The change of position is made during each return stroke.

The ball joint at the tang end of the file (see the illustration) is fixed to the reciprocating head, merely permitting a movement about its own center. The ball joint at the opposite or outer end of the file is also carried by the reciprocating table. This ball joint travels in a circular path, of 1/16-inch radius, in a plane at right angles to the axis of the file. The small rotating movement of this outer ball joint is obtained by turning the socket for the ball, so that the socket has 1/16-inch eccentricity relatively to the center of the disk which carries it. On the edge of the disk, worm-wheel teeth are cut gearing with a worm, so that the worm wheel rotates once for every forty-eight double strokes of the file. In other words, there is a change of position at each double stroke of 1/48th of a revolution of the outer ball joint, about the center of the disk which contains it. The disk and worm gear are carried by the outer reciprocating headstock. It will be noticed that this mechanism amounts to a movement of the center line or axis of the file in such a way that the axis describes a cone, the diameter of its base being ⅛ inch. The face of the file is in the two extreme horizontal positions of the ball joint slightly inclined to the face of the work.

A further problem was how to convert the reciprocating motion of the table into a rotating motion of the worm wheel in one direction only. This is accomplished by fixing on the axis of the worm a cycle free wheel with teeth on its outer edge gearing with a chain fixed between two stationary points of attachment. When the table reciprocates, the wheel runs free in one direction and grips the worm spindle in the other, resulting in the rotation of the worm always in one direction, the worm rotating during one stroke and remaining free during the opposite stroke.

RESULTS OF THE CHANGE

A large number of tests have been made with this apparatus, the results of which have been to remove almost entirely the irregular results previously obtained from files of similar quality. They have also thrown considerable doubt upon the statement, which by this time seems to be fully believed, that a large difference of cutting power exists very generally between the two sides of the same file. That differences do exist is certain, but not to the extent sometimes stated. Experience with these tests has in past shown a singularly small difference, the average result, including a few extreme cases, amounting to not more than a ratio of 1: 1.1.

DURABILITY TESTS

It is true that the tests have been made up to a limit of forty thousand strokes only for each test, and it is pos-

sible that the durability test, that is, the prolongation of the test till the file entirely ceases to cut, might modify these results. This, however, raises the whole question of durability tests. These tests, in the opinion of Professor Ripper, should not be carried on till the file entirely ceases to cut, but should be carried rather to where the file would, in ordinary practice, be considered unfit for further use, which condition would be reached when the rate of cutting has fallen to say one-fourth of the standard of cutting required for the sharpness tests. It seems desirable also to allow a weight of 30 pounds during the first portion of the test in order to determine the cutting power, and then to increase the weight say to 50 pounds for the remainder of the test, which might then be considered a separate durability portion of the test. In this way much time would be saved.

In one case a considerable difference was found between files made by the same firm. On investigating these files with a microscope, it was found that there was a marked difference between the shape of the teeth in the case of the best and the worst of the set.

The Distribution of the Pressure

It may be contended that the arrangement now proposed is equivalent to adding additional weight to the bar, because alteration in the position of the file relatively to the face of the bar tends to cause the file to bear on a portion only of the area of the face, and thus the pressure per square inch between file and face is increased. To what extent this is true depends entirely on the rate at which the change of position of the file takes place. Its change of position can be made to occur so slowly that the file bears over the whole area of the surface every stroke. The present rate of one small cycle of movement every 48 double strokes seems satisfactory, because it does not appear that the rate of cutting under these conditions is greater than under the old conditions. The only difference is that with the new method of cutting abnormal results disappear, and the curves obtained for the same make of files, or for the two sides of the same file, are generally remarkably similar and regular in character. The feature of the mechanism and the principal point to be secured is a change of direction of motion of the file, stroke by stroke, instead of a constant repetition of the same path. It is plainly possible to give the file such a motion in one plane only by giving it a slight rocking motion in a vertical plane without any sloping whatever of the face of the file in relation to the work. The objection of the reduced area, and therefore increased pressure per square inch, would then be removed entirely. The present arrangement, however, gives the file an excellent chance to do its best.

The test bars used are made to the specification suggested by Prof. J. O. Arnold of the metallurgical department of this university. The bars are 1 inch square and 3 feet long, and are of the following composition:

C	Mn.	Si	P	S
0.89	0.30	under 0.1	0.02	0.02

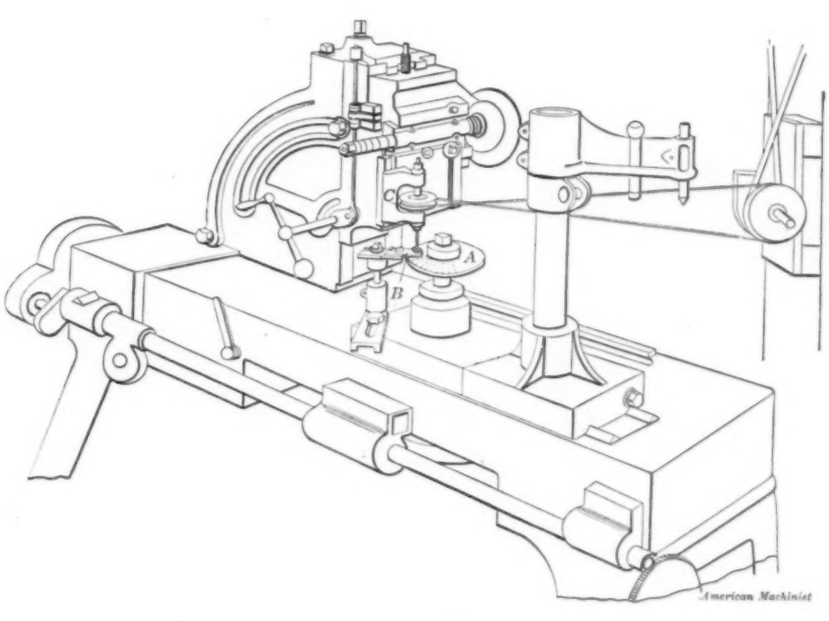
Drilling Index Plates on Gear Cutter

Editorial Correspondence

A novel application of a gear cutter in the process of drilling index plates for milling machines.

What appears to be a new use for a Whiton gear cutter is seen in the accompanying illustration which shows the process of drilling index plates for the milling machines manufactured by the Waltham Watch Tool Company, of Springfield, Mass.

It will be seen that the blank index plate *A* is mounted upon the vertical spindle which carries the gear blank when the machine is used as a gear cutter. Upon the sliding head, which carries the milling-cutter spindle, there is bolted the headstock of a small watch lathe, which carries a small drill to drill the index holes.



Drilling Index Plates on Whiton Gear Cutter

Guide plate *B* is supported from the machine as shown, and at its outer end carries a drilling bushing. This plate *B* is adjustable along the radius of the index plate *A*, so that it is possible to set it for the different concentric circles of holes required. It is, however, held from turning sideways by a latch, thus insuring the accurate spacing of the holes drilled.

First, the change gears are set in the proper ratio to index for the proper number of holes for the outer circle, and the automatic connections being made, the operater raises and lowers the head carrying the drill, by means of the handle shown. As in the ordinary operation of gear cutting, the rotation of the plate *A* takes place automatically when the head is raised, thus spacing the holes as they should be.

All of the index-plate blanks are thus first drilled around the outer circle and then, by means of a gage, which locates the first hole of all the circles from the first hole of the outer circle, the second circle is drilled, the change gears having been arranged to index for this new number in the second circle. All the plates are then drilled for the second circle, and the change gears are again altered to suit the spacing for the third circle, this being continued until all the circles of all the index plates are completed.

As will be seen, the drilling head is driven from a small countershaft located near the machine.

The Real Value of a Lubricating Oil

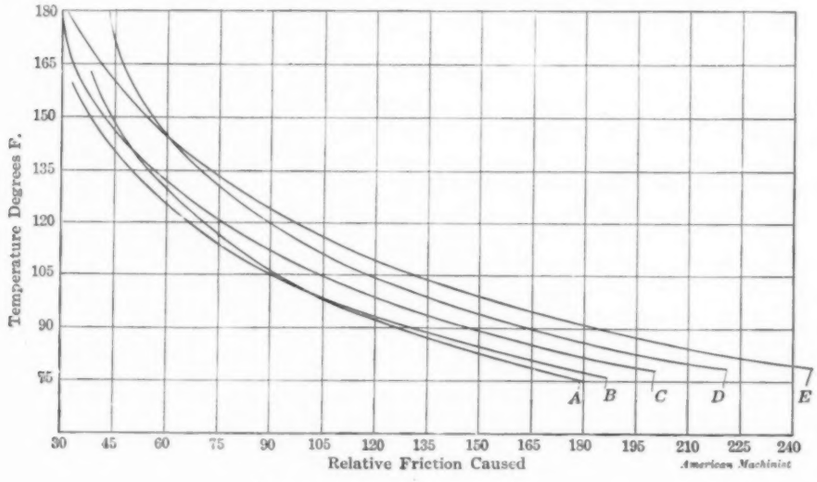
By Con Wise

The real merit of a lubricating oil does not depend upon the ability or agreeable traits of the oil salesman, but upon the qualities of the oil as a reducer of friction.

The only safe guide is a careful study of test results, and the test conditions should be as nearly as possible those to be met when the oil is in use.

Buying belting, oil, belt dressing, babbitt, etc., is one of the least satisfactory parts of conducting a shop. The advice usually given is to pick out a good reliable house and put yourself in its hands. This advice I have no doubt is good as far as belting goes, and possibly as to belt dressing and babbitt metal, but I have come to the conclusion that it does not apply to oil, especially lubricating oil. The results of the use of these other commodities are in a way tangible. Belts stretch and give out. Belt dressing will preserve them. Babbitt metal will run cool, or it will not. The results are in plain sight and it is comparatively easy to find something that answers, by repeated trial.

Cutting oil depends for its value on tangible results, the smoothness of the cut with drilling tools and the preservation of the tools. Some of your readers will say: "That is also true of lubricating oil; we can see if bearings rough up, or if they run hot." True, but an oil may keep bearings cool and smooth and be terribly expensive oil. The intangible element in lubricating oil is power consumption. In a cotton factory it is possible to test oil in a broad and highly practical way, because the working load is very constant and difference in lubricating value of oils is readily noticeable in the engine indicator diagrams, and also in the coal pile. In a machine shop the power requirements are so variable that the difference in lubricating power of oils is forgotten.



CURVES OF OIL TEST RESULTS

THE SALESMAN'S PART

We have aways bought our oil as a matter of accommodation to some good-looking, civil and plausible salesman, and until recently supposed that he knew what he was selling us. We thought we were getting a special confidential discount, till we found that some of our friends were also getting still more special and extra-confidential discounts. Then again, when we began to inquire about coefficients of friction, etc., we found that these good-looking, civil and plausible salesmen either did not know, or knowing, would not tell. We could get absolutely no satisfaction beyond the customary assurance that So & So had been buying of them for years and were perfectly satisfied. Inasmuch as several other salesmen claimed to have the exclusive trade of So & So in the same line, we began to wonder if even the big buyers knew any more about oil than we did.

Having concluded that we knew nothing about the oil business, we started to decide what we wanted to know about it, before we ordered again.

Price is of course a consideration, but as I will show later, it is a minor one. Some oils are expensive if given away.

Endurance is of equal importance, but no more. An oil may be low in price and may stand in the boxes for a long time without change, and still be a very expensive oil.

Power is what costs. The oil that saves power is the cheap oil. Power is used in a machine shop mainly for three purposes: To cut metal, bend belts and overcome friction of bearings. The last usually consumes the largest part of the power and the first consumes the least. To be sure power cost is one of the smaller items in most shops, but the lubricating-oil bill is so much less that parsimony in the latter, at the expense of the former, is not to be thought of.

ACTUAL TESTS THE ONLY BASIS

During the summer we were fortunate enough to find a college professor and an oil-testing machine, both at liberty. The machine is one in which a journal (hardened and ground) runs in a bearing on which a variable pressure can be exerted. The journal can be run at variable speed, and the whole thing can be heated to different temperatures, not by its own friction, but by outside heat. We turned over to him five samples of oil submitted by different houses, all of whom knew the purpose for which we used oil, and also that we were going to test it.

We had tests running from 70 to 150 pounds pressure per square inch, and from 140 to 225 feet per minute surface speed, which covered our range of use except for a small amount of machinery in the pattern shop and some underloaded motors. We found that there was no decided variation in the friction caused by variations in either pressure or speed between these limits. We then tried variation in temperature, with rather marked results, as will be seen from the accompanying chart.

Oil *A* showed the least friction up to 100 degrees temperature; above that, oil *B* took the lead, though apparently oil *C* would have beaten it out at about 170 degrees.

Inasmuch as a bearing at 100 degrees feels perceptibly warm to the hand, we decided on the oil which gave the best results below that temperature. There is no reason why bearings should not be run at higher temperatures, and if it were not for the expense attending heating the bearings, there would be a decided advantage. Of course, it does not do any good to let a bearing run hot, because when it begins to heat up from its own friction it rapidly gets too hot, and goes far above the range of these experiments.

Now let us see what the money value

of these experiments may be. All these oils are sold at from 20 to 25 cents per gallon, so there was little choice in that respect. We are running on electric power coming through a meter. Our friction load, allowing about $10 a month for bending and stretching belts, is costing us practically $30 per month, using oil *A*. At 80 degrees temperature, which is about what our boxes are running at, oil *E* would cause 240/160 of the friction that we now have. This is 50 per cent. more, or $15 per month extra; $180 per year. As we use about 240 gallons of lubricating oil in a year, or say $50 worth, it will be seen that the maker of oil *E* should give us the oil and $130 per year to boot, to induce us to use it.

If we should run our boxes at 100 degrees, as we undoubtedly do during the hot weather, our power for overcoming friction should drop from 160 to 105, or to about $20 per month. At this same temperature oil *E* would cause nearly 40 per cent. more friction, or about $8 per month loss, in which case the maker of oil *E* should give us the oil and $46 in money. If we had any way of getting up to 130 degrees, we could cut our loss of power to $10 per month using oil *B*, and then oil *E* would be 40 per cent. poorer, as before. Above that temperature oil *E* gains rapidly, but *D* stays just about the same amount to the bad at all temperatures.

The "Secret Compound"

Just as a matter of curiosity we sounded the maker of oil *E* to see what might be the trouble. We found it to be a curious one. He is also the maker of oil *B*, which, however, was submitted to us separately. In order to improve oil *B* and aid in its sale, he adds to it a small quantity of 75-cent cylinder oil, and is selling it right and left as a great improvement over oil *B*, and at a less profit to himself, for he sells both at the same price. The effect is just what he should have expected; the cylinder oil renders the mixture sticky at low temperatures and begins to show its value only at temperatures far above those common outside the engine room.

This particular oil has an advantage that should not be overlooked and that is that it will undoubtedly stand a higher pressure, and in case of an emergency would be a great help. We prefer to use an oil that is economical for everyday use with everything well lined up and running smoothly, and then we can run to the engine room for a little cylinder oil to add if some bearing roughs up and cuts so that it increases the pressure per square inch by reducing the real bearing area.

We feel now that the price of lubricating oil has less than nothing to do with its value, and that the only basis on which to buy is an actual test.

A Multi-cylinder Boring Machine

By C. L. Goodrich*

The building of automobiles, as we all know, has reached proportions of magnitude and caused the design and development of many machines for the economical manufacture of the various component parts.

The accompanying halftones illustrate a vertical multi-spindle boring machine, together with jigs, etc., which has been brought out by the Pratt & Whitney Company for boring automobile-engine cylinders.

This machine differs radically from other methods in that it simultaneously bores cylinders, thus resulting in a large daily output. Briefly, the machine, Figs. 1 and 2, may be described as having 12 rotating cutter bars, each of which is guided in long adjustable bearings and driven by gearing through substantial ball joints. The cylinders that are to be bored are clamped to a revolvable balanced jig plate (see Figs. 3 and 4), which, as is fully shown in the illustrations, is part of a car and which may be readily moved, on tracks shown, from outside of the machine proper to directly underneath the cutter spindles.

The unloading of bored cylinder castings and the reloading of rough cylinders is obviously done while the car is free from the machine. In order to most efficiently utilize the equipment, two cars, together with jig plates, etc., are provided and thus the machine may be kept in almost continuous operation, in that when a batch of cylinders is being bored, another lot is being loaded upon the empty jig plate, and the operator upon completion of the boring of the cylinders under the cutter spindles slides the car together with the finished work from underneath the machine and directly slides the new-

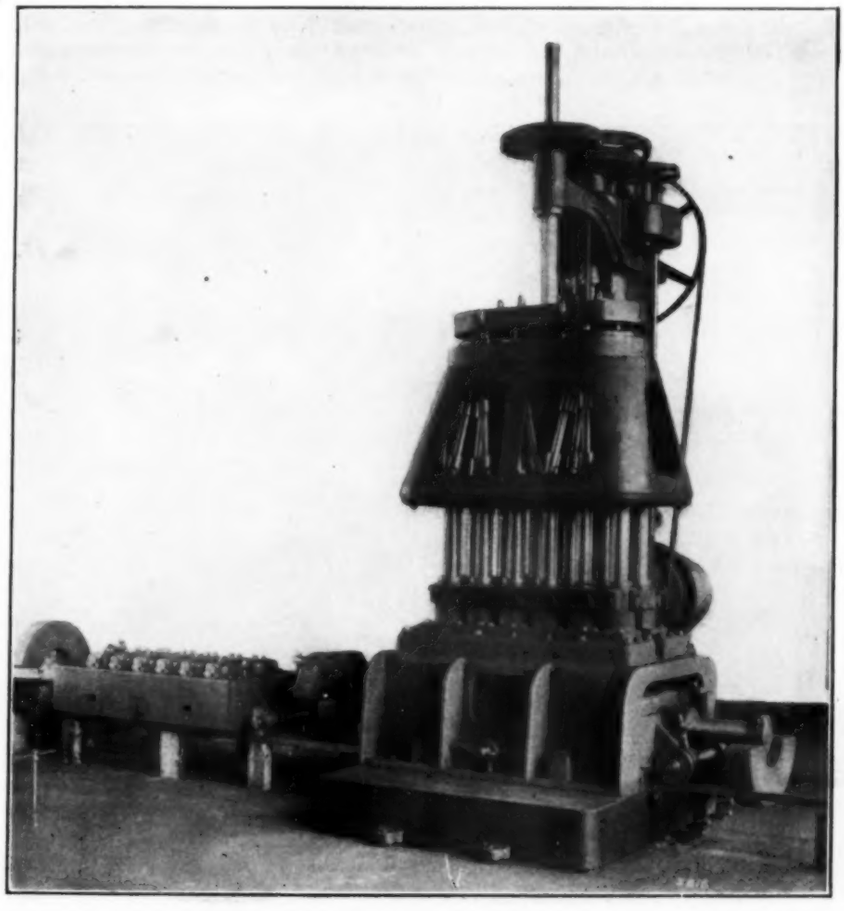


FIG. 1. SHOWING JIG UNDER SPINDLES AND OTHER JIG LOADED AND READY TO SLIDE UNDER SPINDLES

*Department foreman, Pratt & Whitney Company.

ly loaded car into its place. This latter car, which is automatically positioned correctly under the spindles, is then quickly locked to prevent movement, and the operator puts in the power feed to the boring spindles and then attends to unloading and reloading the car of bored cylinders.

The design of the cutter bar supports permits of adjustments so that single, double or *en bloc* cylinders may be accommodated. In the particular boring machine described there are 12 spindles, which number, however, may be varied where conditions require it.

Ample driving power is insured by the high belt speed and gear reduction. The machine is exceptionally rigid.

Some users of the equipment rough bore and grind the cylinders, while others prefer to rough and finish bore. The finish boring leaves the interior of the cylinder very smooth and round. In the opinion of the Pratt & Whitney Company, boring is superior to grinding.

Due to the large output possible under conservative cutting speeds, there is everything to commend the use of slow speeds, and not only is tool grinding less frequent, but less distortion to the cylinder results. At a cutting speed of 20 feet per minute, 12 cylinders 4½ inches bore by 9 inches deep are bored (one cut only) in 14 minutes. Where two boring cuts are taken at low cutting speeds, 250 is a conservative daily output.

The jigs which are shown are admirably suited for the majority of cylinders, although where the bore extends entirely through the casting a somewhat simpler design of jig is made possible. In all cases the castings are located to the jig plate by the same holes in the base as are utilized to fasten the cylinders to the crank case.

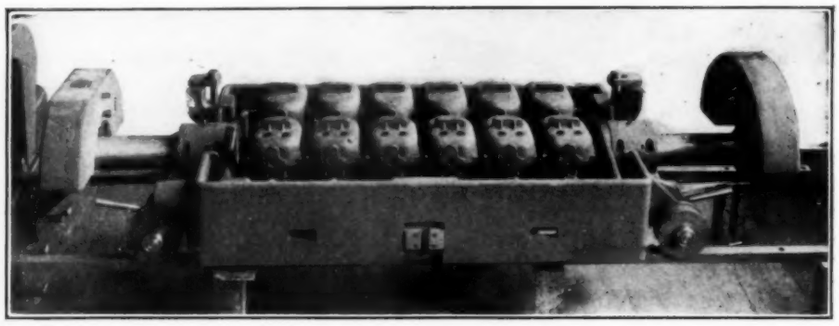


FIG. 3. REVOLVING JIG AND CAR AS CYLINDERS ARE LOADED

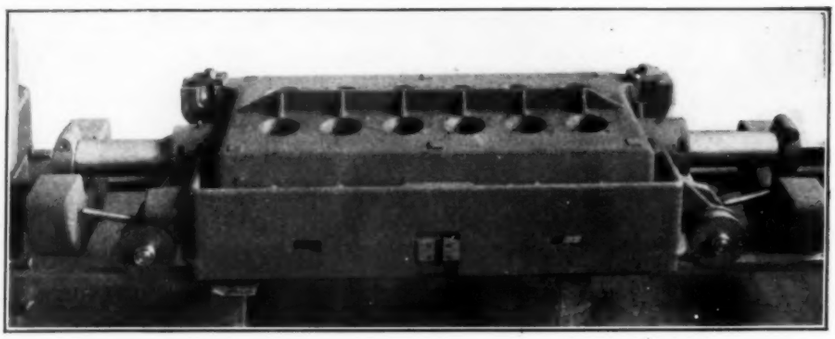


FIG. 4. SHOWING CAR WITH JIG AND CYLINDERS ROTATED INTO WORKING POSITION

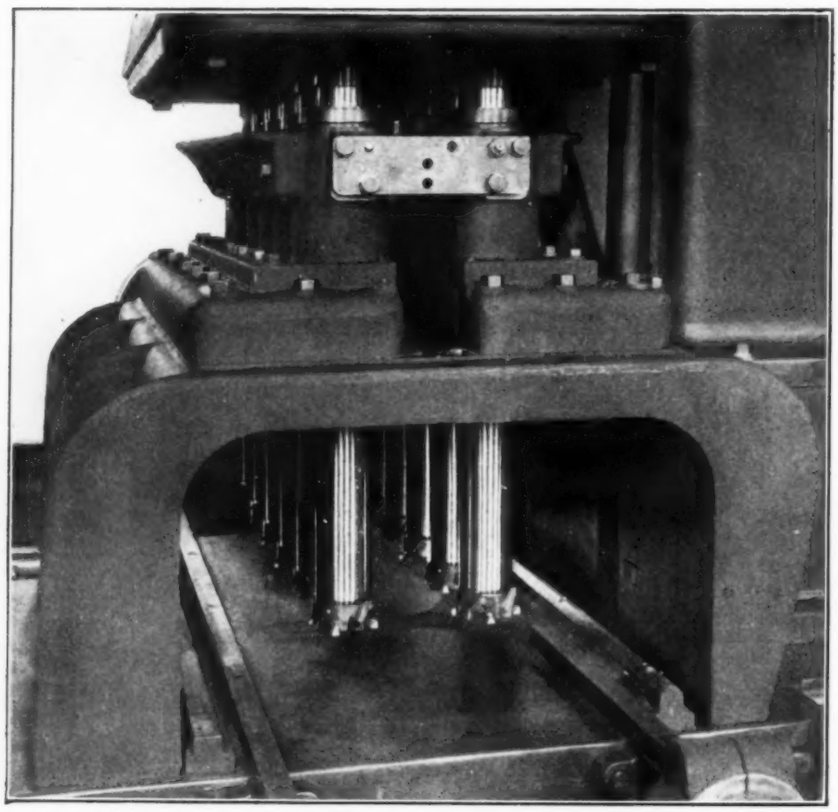


FIG. 2. SHOWING SPINDLES AND CUTTER HEADS

Counterbore Kink

BY PAUL CAMPBELL

The kink herein described is illustrative of the class of stunts that are often born of necessity and in extreme haste and are performed every day in tool rooms and jobbing shops.

With the advent of high-speed twist drills we discarded our supply of carbon drills as unsuited to the new conditions. The old drills remained, for a long time, an eye-sore to the tool-crib keeper. Finally, however, someone discovered that a handy "hurry-up" counterbore could be made with little trouble from a twist drill.

An abundance of counterbores of all sizes is a boon to any tool room and especially so where many jigs are made in the drill press.

Now, when a new or special counterbore is needed a drill is selected of the proper body size of the intended counterbore and is end turned for the pilot. All our supply of carbon drills have been annealed with this object in view. It is then backed off and hardened and the result is a spiral fluted counterbore is at work in 20 minutes.

A New System of Screw Limit Gages

By William Taylor*

For the high class of workmanship involved in scientific instrument making I have found the usual form of screw gage, that is, a hardened and threaded plug and a threaded hole in a hardened plate, to be entirely unsatisfactory. Moreover, for work of a less exacting character it is obvious on close examination that any system of limit gages for screws based upon the use of such gages alone is fundamentally wrong.

Pitch, pitch diameter and angle of thread tested conjointly, root and outside diameters independently.

*Governing director, Taylor, Taylor & Hobson, Ltd., Leicester, England.

Defects of the Common Form of Gage

From the geometrical standpoint the objections lie chiefly with the not-go gage.

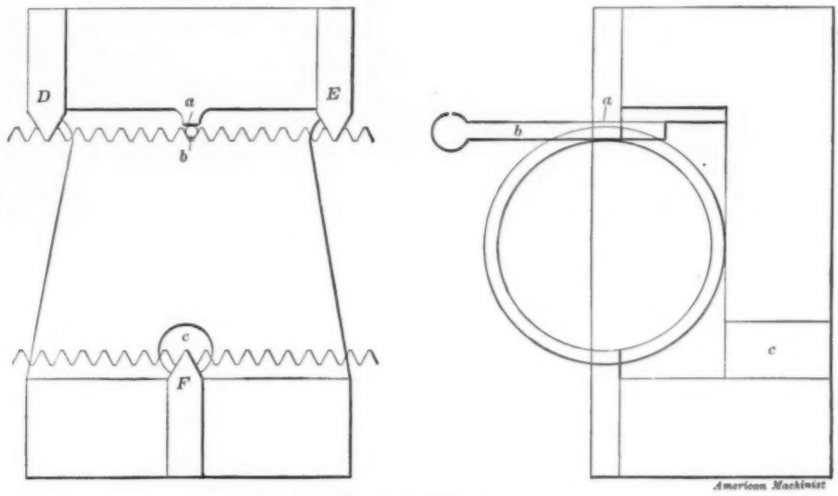


Fig. 1. The Taylor Screw Gage

Considering a go gage in the act of gaging a nut, it is obvious that if the gage enters, the nut is at least large enough in all of its elements. When it comes to the not-go gage, however, there is no such degree of satisfaction if it refuses to enter the nut, because there are at least four elements in a screw thread, any one of which may prevent the gage from entering the nut, although in its other elements the nut may be actually larger than the gage.

Two of its elements are the outside and the core diameters respectively. If either of these is too small, the gage will not enter, regardless of the pitch diameter. Similarly, although the pitch diameter of the nut may be larger than that of the gage, an error in the thread angle may prevent the gage from entering at all or an error in pitch may prevent its entering fully; and in no case are we able to determine which element rules.

From the mechanical standpoint, however, the go gage is worse off than the not-go gage, because of the larger amount of wear to which the former is subjected. In the nature of the case, only the few nuts which are too large go on the not-go gage, while these that are correct and those that are too large go on the go gage and, with the nature of the motion involved in putting threaded surfaces together, this gage is subject to too much wear for such an instrument.

It long ago became obvious to me that the last word in screw gages would not be said until the separate elements of a screw were independently tested with not-go gages, and the result of this conviction is the system of screw gages shown herewith.*

The New Screw Gage

Fig. 1 shows in diagrammatic form the gage for testing screws, the usual tapped plate being replaced by a U-shaped block carrying three V-shaped gage points *D E F*, the distance between the points *D* and *E* being generally equal to the thickness of a standard nut. Opposite the single V gage point is a flat stop *a* which is used in connection with a small wire gage *b*, of such size that it will not enter the space indicated unless the screw is too small.

If a screw enters the gage, as shown in outline, the fact shows that the screw is

*We understand that, for purposes of record, Mr. Taylor has taken out a British patent for the gages shown, and then presented the patent to the British Engineering Standards Committee, of which he is a member. The halftones are from photographs of a set of gages which have been deposited in the National Physical Laboratory.—Ed.

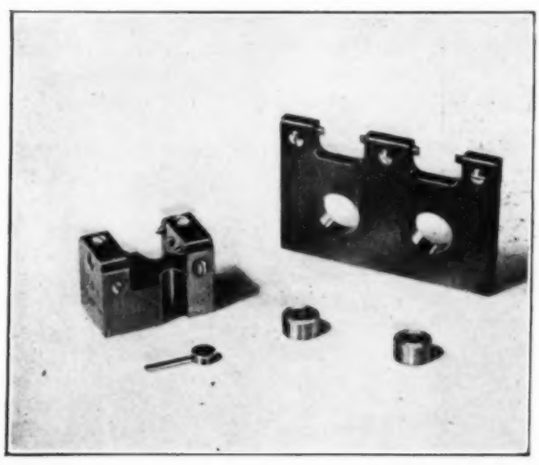


Fig. 2. The Screw Gage Complete

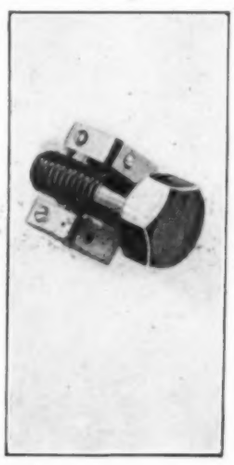


Fig. 3. Gaging a Screw

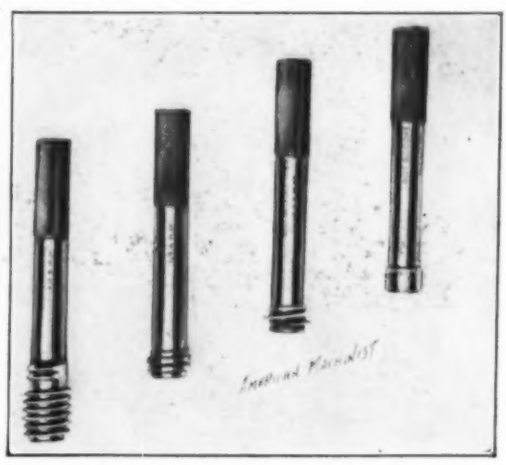


Fig. 4. The Nut Gages

everywhere small enough while, if the wire gage enters, that fact shows it to be too small. If the pitch is in error the screw can only enter if its pitch diameter is too small, which will be shown as just pointed out, and the gage will thus be seen to test pitch diameter and pitch conjointly. These elements are so dealt with because they are in practice interdependent, any error in pitch necessitating a reduction of pitch diameter in the case of a screw (or an increase in the case of a nut) in order that the work shall pass the go gages and interchange. The rod gage is of such size as to bear on the threads at their mean depth and in limiting errors of pitch and pitch diameter it takes also into account any error in the angle of the thread which, whether it be too great or too small, affects the pitch diameter at this point. The cut-away upper sides and the peep hole *c* permit effective inspection of the condition of the gage points which can be set to a master threaded plug.

The appearance of the gage is shown at the left in Fig. 2, the wire-rejecting gage being seen in the foreground. At the right is a hardened plate having two plain holes, marked go and not-go, for the outer diameter, while two pairs of caliper jaws in the upper side of the plate act as go and not-go gages for the core diameter. These jaws being liable to wear because of their comparatively small acting surfaces, they are supplied with means of adjustment and with two reference disks shown in the foreground, by which they may at any time be reset. The gaging of a screw is shown in Fig. 3.

The New Nut Gage

Fig. 4 shows the independent plug gages for gaging nuts. The plug at the left is the go gage, the full length of a standard nut, with some extra threads at the root end, which may be used in adjusting the gage shown in Fig. 1. The second plug, counting toward the right, has the threads ground off by about one-third of their depth, while the bottom third of the thread depth is cut sufficiently clear, leaving only the middle third to gage the sides of the threads at about the center of their depth. This gage, in conjunction with the go gage, limits errors of pitch and pitch diameter conjointly, and therewith takes account of errors of thread angle. The third gage except at its crests has its thread cut to clear the nut and is a not-go gage for the root of the thread, while the plug at the extreme right is a not-go gage for the core of the thread.

Certain fundamental principles embodied in the design of these gages seem capable of general application to limit gages for objects, including two or more dimensions. They are:

1. A go gage may measure all the elements of an object simultaneously; it *must* do so in order to determine the relative position of the elements.

2. A not-go gage cannot deal simultaneously with two or more elements, unless the elements are interdependent (as are the pitch and pitch diameter of a screw) and can for this purpose be treated as one element.

Separate not-go gages *must* be used for separate and independent elements.

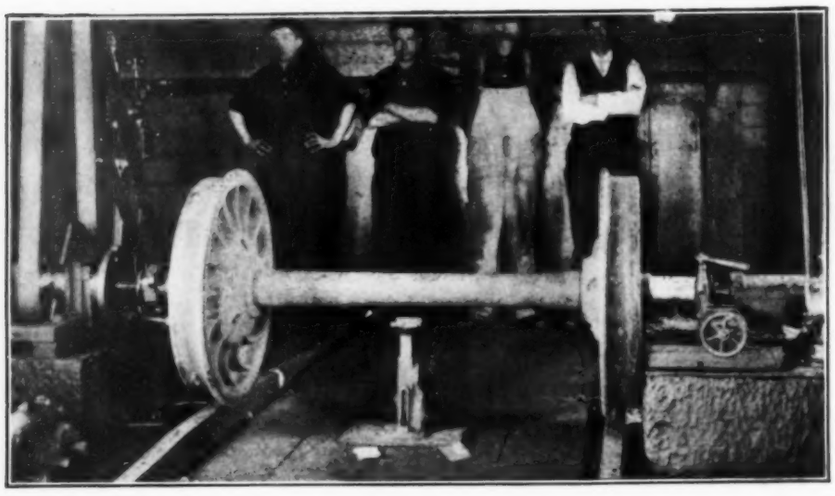
A Homemade Lathe for Car Wheels

By W. J. Shadle*

Attached print shows a homemade lathe that is used to turn tender, car and trailer journals and after being in use for nine years I can honestly say that both its output and its work are excellent. The convenient method of applying and removing wheels from this lathe is what counts. All that is required is to roll the wheel on the standard-gage track to the lathe centers and jack it to the center of the lathe by the stationary jack located there for this purpose. The power for this lathe is furnished by a small upright engine with a 5-inch cylinder. It is run by air pressure. The headstock of the lathe is cast iron and has ball bearings to take the end thrust. The tailstock is cast iron with ways for the tool post cast in one piece. The feed to the tool is procured by crank on the end of the overhead shaft and a rod to the ratchet on the tool-post screw.

The headstock and tailstock are lined up and bolted down to a stone foundation, making a solid construction. There is a small pit 27x22 inches deep, boxed in at tailstock end of the lathe, which makes it very convenient for the operator of the lathe. This lathe is placed in a house outside the shop. There is straight track running through with doors in each end of the building. These swing up to allow the largest wheels to pass under. The cut journals are unloaded from flat cars at one end of the building and as they are turned they pass out at the other and are loaded on cars ready for shipment. I will not attempt to give you the output of journals turned per day in this lathe, as I know you would consider it a dream, but I will say that any foreman who is now trucking wheels into shop and tying up a good lathe on this class of work will never regret if he builds one like the attached print.

*Shop foreman, C. & N. W. Ry., Clinton, Ia.



A Homemade Lathe for Car Wheels

How to Remove a Stubborn Nut

By H. D. Chapman

After all ordinary methods have been tried to remove a nut that has become tight from rust, or has galled and stuck, you can try this little kink. Heat an open-end wrench that fits the nut and while hot place it on the nut and allow it to remain for two or three minutes. The heat will cause the nut to expand and it can then be taken off with ease.

A heated wrench gives much better results than a blow torch, as the torch will heat the nut and bolt at the same time, where the hot wrench only heats the nut.

Any nut which resists the hot wrench will probably have to be split to take it off. This is a favorite method used by marine engineers for removing nuts on pipe flanges where they have been put *on paper* by the designers.

Engine Patterns and Core Boxes

Editorial Correspondence

The patterns and core boxes required to mold a small vertical engine frame, and the casting as it leaves the mold. The form and shape of the pattern, core prints and core boxes. The loose pieces that are required in the main body core and the small core boxes needed to complete the correct impression in the sand for a perfect casting.

The pattern and core boxes used by the B. F. Sturtevant Company, at Hyde Park, Mass., for casting the frame of its VS-7 engine, is herewith illustrated. It is one of those patternmaking jobs in which by far the largest amount of designing and labor, on the part of the patternmaker, is expended on the core boxes.

The pattern is built up solid and parted on the center line, as shown in Fig. 1. The work on this consists of building up the pattern to the exact shape that the engine frame is to be, and making it enough larger to allow for the shrinkage of the metal in casting, and also for machining on the various surfaces desired. After this the core prints are fastened to the pattern. Four of these are shown in the illustration, while one other is located on the top, and one on the back of the pattern as shown.

Cores

The core for the main body of the engine frame is made in two half boxes like those shown in Fig. 2. One-half of the main core is then located in the drag of the mold, while the other half is hung in the cope. Loose pieces are put in these two boxes at *A* and *B* to make impressions in the sand for the iron that forms the guides for the slide valves. Two other loose pieces are located at *C* and *D* to act as braces and also form a board that is to be drilled. Aside from these the boxes are built up solid to the shape required.

Fig. 1. Completed Pattern with Its Core Prints

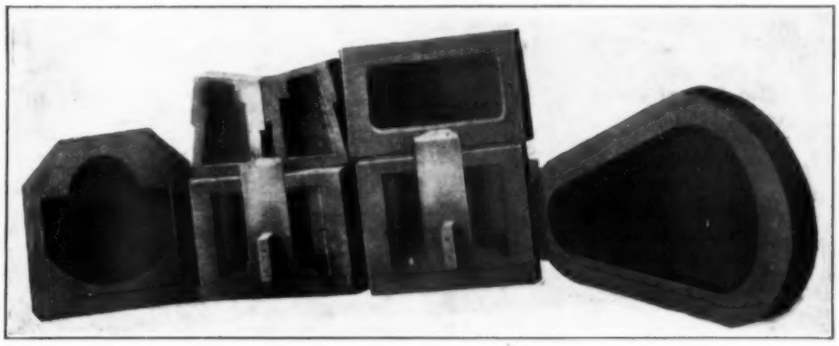


Fig. 3. The Small Core Boxes

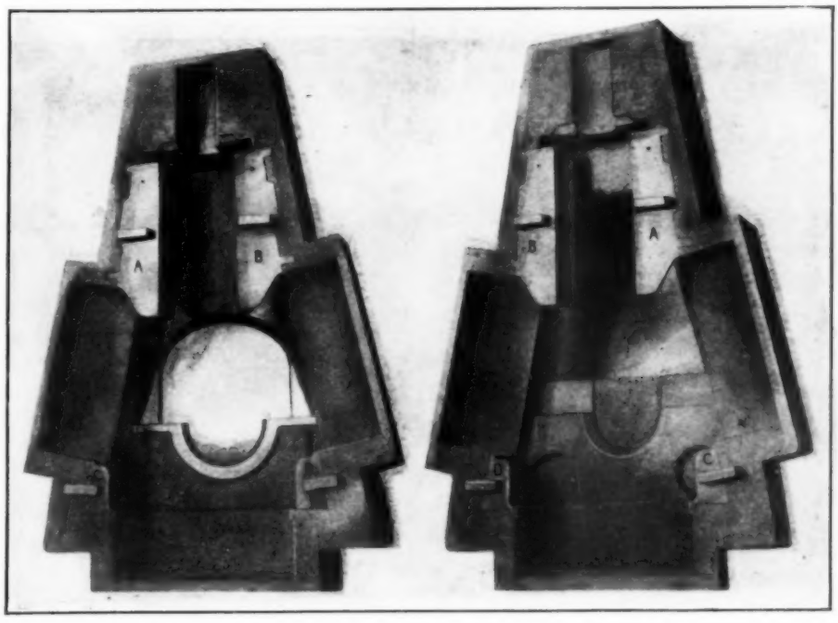


Fig. 2. The Two Half Core Boxes for the Main Core

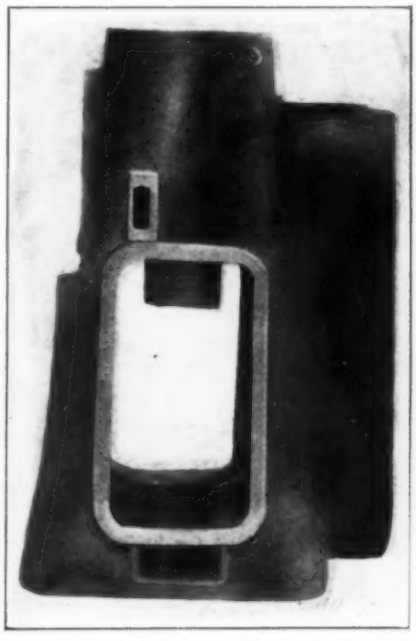


Fig. 4. The Casting as It Leaves Mold

Several smaller core boxes are shown in Fig. 3. These are required to complete the desired shape in the mold. Three of these are made to fit coreprints on the pattern. The other four are to give the mold a shape that could not easily be done in the two half boxes for the main core.

The casting, as its leaves the mold and is ready to be sent to the machine shop for the various machining operations. is shown in Fig. 4. This is just as it leaves the mold, except that the risers, sprues and gates have been chipped off, and the cores have been knocked out.

A Large Shop Air Compressor

Special Correspondence

An installation of a very large compressor which illustrates the growing use of compressed air as a factor in shop operation.

The Chicago & Northwestern Railway locomotive car and repair shops are situated at Fortieth avenue, in Chicago, and run from the main line of the Galena division at Kinzie street to Chicago avenue on the north, and from Fortieth avenue on the east to Forty-sixth on the west, covering about 25 city blocks. About 3000 men are employed at this plant.

Compressed air is used for power in the machine shops, blacksmith shops and forge shop, wherever possible for all sorts of purposes, such as riveting, drilling, chipping, reaming, calking and many other special purposes.

Air power for these purposes is supplied by two air compressors in the main power plant. One of these is a Corliss, cross-compound, condensing two-stage unit of 1500 feet capacity. The other is a Sullivan tandem, Corliss, compound, two-stage machine, with a capacity of 2450 cubic feet of free air per minute. The average daily air during the day shift is from 2600 to 3000 feet. The Sullivan machine has been installed for about a year and a half, and has proved very satisfactory for shop service of this sort, as it occupies only about half as much floor room as the cross-compound machine referred to and its economy is equal to the other.

A large range in speed and capacity is secured partly by the very heavy flywheels which are employed, and particularly by the design of the speed and pressure regulator, which was adapted especially for this type of compressor. The speed of this machine is increased and decreased not by throttling the steam, but by varying the automatic cutoff on the steam cylinders to suit the load and speed automatically, thus admitting to the cylinders, the full initial pressure at all times, whether the machine is running fast or slow.

When the speed of the compressor reaches a point at which the air supply exceeds the demand, the speed element of this governor slows the machine down. The same effect is produced when the air pressure exceeds the point at which the pressure element is set to act. These two elements of control, therefore, act in unison or independently as required to maintain the speed of compressor at its most economical point.

The four steam and air cylinders are tandem with each other, keeping the

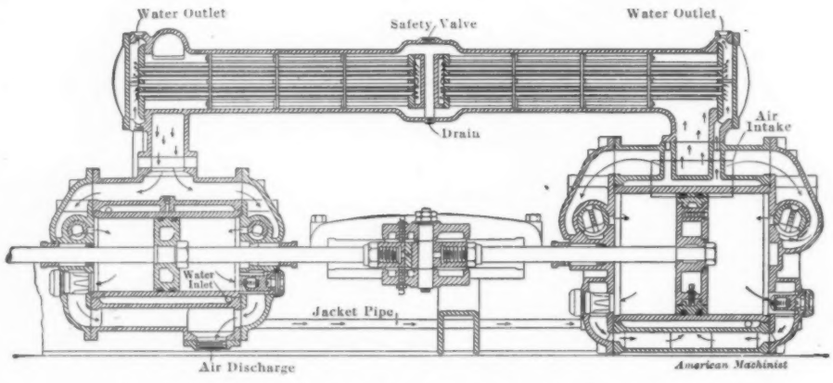


FIG. 2. SECTIONAL VIEW OF AIR CYLINDERS AND INTERCOOLER

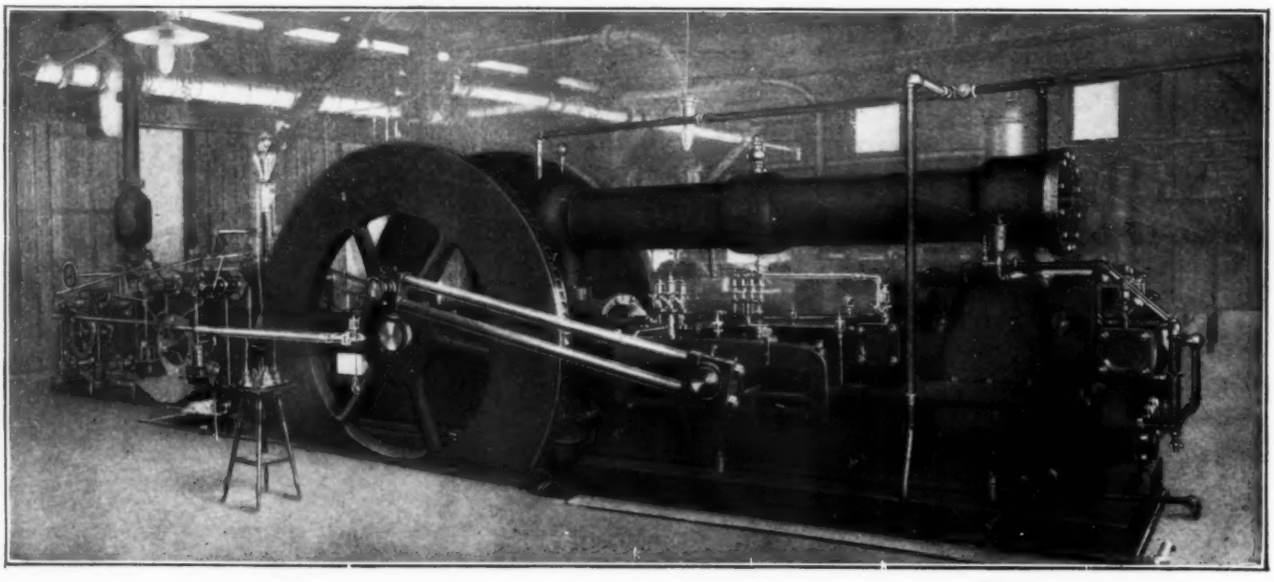


FIG. 1. A LARGE SHOP AIR COMPRESSOR

working strains in a straight line and avoiding the necessity of such heavy construction as is required in a cross-compound machine. The machine is practically self-contained, the entire air end and low-pressure steam cylinder being secured on a continuous iron frame or bed plate.

The cylinders are water-jacketed, and a very large proportion of intercooling surface to cylinder volume is provided in the shell, shown above the cylinders, by two separate nests of copper tubes. By means of baffle plates, the air is forced to pass several times across the cold-water tubes, in its course from one cylinder to the other, thereby removing practically all the heat of compression generated in the intake cylinder. The air enters the machine through a large conduit, which opens into the basement of the power station. A constant supply of cool dry air is thus assured. The valve gear on this machine is of the standard Sullivan type, employed on all its larger machines. The air-inlet valves are of the semi-rotary or Corliss class.

We are indebted to Mr. Rice, engineer of the power plant, and to J. Smith, superintendent of shops, and the makers, the Sullivan Machinery Company, Chicago, Ill., for courtesies in the preparation of this article.

Use of Black Bar Stock in England

Editorial Correspondence

The use of bright-steel bars for turret-lathe work is far less common in England than in this country. In addition to the increased cost of bright stock is the fact that required grades of material can be obtained much more readily in the black than in the bright form—some desirable grades, especially high grades, being, in fact, not obtainable at all in bright bars. Moreover, in many cases the bars are put through a heat-treating process before use, which destroys the surface of the bright bars.

The presence of scale on black bars and the fact that they are not sufficiently straight for satisfactory use in turret lathes, has led to the design of a system of "reeling machines" for the removal of the scale and for straightening the bars, and through the courtesy of Alfred Herbert, Limited, of Coventry, we are able to present herewith some photographs of these machines. This company not only supply these machines to the trade, but have equipped a department of their works for the treatment of the bars, in which they have a large trade among those whose requirements are not sufficient to justify the installation of the machines. The entire practice is a most interesting illustration of a fundamental difference in methods pursued in the two countries for substantially identical classes of work.

Fig. 1 gives a bird's-eye view of one of these machines from the delivery end, the treated bars being seen in the right foreground. The bars are fed into the far end of the machine, through the strong cast-iron tube shown, the operator being provided with a pusher rod for pushing the bars into the rolls. As the bars pass through the machine they enter the receiving trough, which is shown in the immediate foreground. After leaving the rolls each bar is pushed into the receiving trough by the next bar. One side of the trough is movable, being pivoted to the shaft shown at the left of the trough. The operator has a handle (not shown) under his control, by which he can lift up the movable side of the trough and thus allow the bar which has been reeled to slide down the incline and make room for the next.

In construction the machines are very simple and rugged, the rolls, which are of chilled cast iron, being one concave and the other convex, and set at a slight angle to each other and to the bar which is being reeled, in order to produce a progressive motion of the bar through the machine.

Fig. 2 shows another machine from a different point of view, which gives a better idea of the general construction and appearance. In this machine the rolls are of different form but the action is the same.

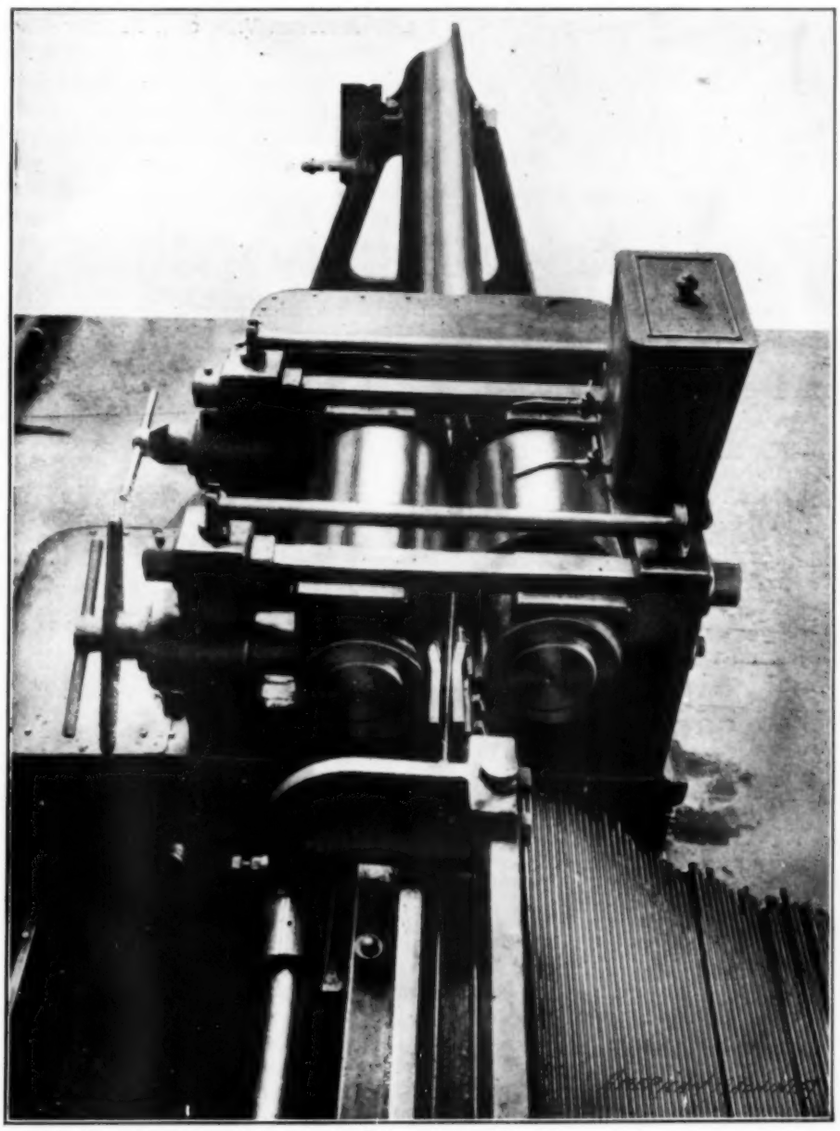


FIG. 1. THE REELING MACHINE AT WORK

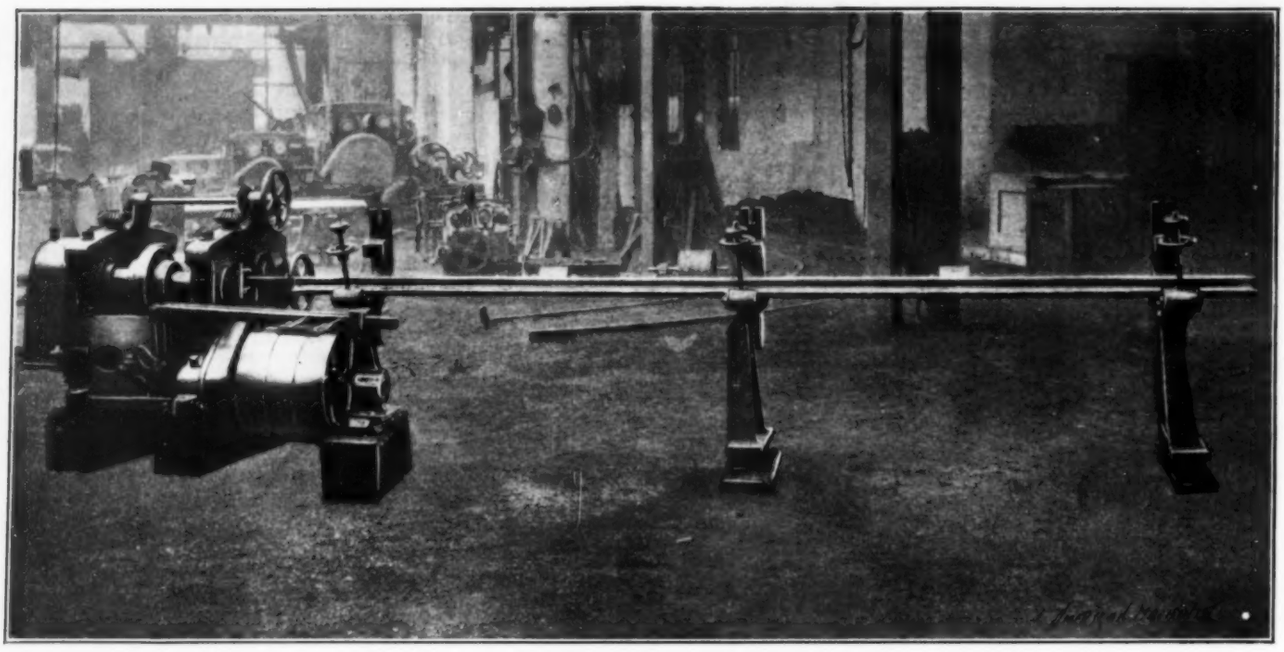


FIG. 2. ANOTHER VIEW OF A REELING MACHINE

The machine shown in Fig. 1 is driven by a variable-speed motor, of which the controller steps are marked with the sizes of bars with which they should be used.

We understand that bars as large as three inches diameter are treated in this way. As they leave the rolls the bars may be described as semi-bright, the scale being entirely removed, and they are of a very satisfactory degree of straightness, though, of course, they are not as straight as cold rolled.

Oxy-Gasolene Torches Used in France

The two photographs reproduced herewith show the "oxy-essence" (oxygen and gasolene) torches made by the company "L' Air Liquide," of Paris, France. This concern, which employs the Georges Claude processes, manufactures a line of appliances for autogenous welding, cutting and brazing. Its apparatus is the same for which the Compagnie des Gaz Comprimés is representative in France, and under whose name it may be better known to some of our readers.

FIG. 1. FRENCH OXY-GASOLENE CUTTING AND WELDING OUTFIT

For a co-combustible with oxygen, the company employs illuminating gas and acetylene alternatively to gasolene vapor, and the appliances for these fuels are based on the same principles, although differing in detail. The flame of the cutting torch comes from two concentric jets, of which the outer, or heating one is oxygen mixed with the other gas, while the inner, or cutting jet is oxygen alone and is turned on only after the work has been brought to a very high temperature.

Thickness of Plates, Inches.	Consumption of Oxygen per Foot, Cubic Feet.	Outlet Orifices, Inches.	Cutting Time, Minutes per Foot.
0.2	12	0.4	0.9
0.4	15	0.4	1.02
0.6	25	0.4	1.32
0.8	28	0.4	1.5
1.6	59	0.4	1.56
2.4	89	0.4	1.8
3.2	118	0.6	1.86
4.0	161	0.6	2.25
4.8	258	0.6	2.4
5.2	269	0.6	2.52

CUTTING SPEED FOR IRON AND STEEL PLATES BY THE OXY-GASOLENE TORCH.

A characteristic of the gasolene torch is an auxiliary flame for vaporizing the fuel and raising the temperature of the heating mixture. The burner for this purpose, which is fed with the mixture, is situated at the short cylinder on the lower tube behind the main burner.

The gasolene is contained in a small portable tank, see Fig. 1, and is forced to the tank by air pressure, the air being pumped into the tank by hand and producing pressure upon the surface of the liquid. Oxygen is taken from the ordinary charged oxygen bottle. Fig. 2 shows

FIG. 2. THE OXY-GASOLENE CUTTING OUTFIT AT WORK

this outfit at work on a riveted tank, being used as a cutting torch.

The makers state that the illuminating gas, acetylene and gasolene torches act with the same ease, but they call special attention to the gasolene one because of its simplicity and compactness. In addition to the gasolene cutting torches intended for ordinary work, they are made to cope with thicknesses of 6 to 14 inches, and upward, and are provided with suitable mechanical guiding appliances for that purpose.

The metal itself acts as a combustible and burns in the oxygen, the heating mixture serving to prime the work, so to speak, for the reaction. Hence, the gas consumption is more or less independent of the thickness of the metal. Six or seven quarts of motor-car gasolene per hour is the quantity commonly required.

We subjoin a table giving data on cutting iron and steel by torches using gasolene, acetylene, or illuminating gas. The figures refer to hand work; where guiding appliances are used the consumption is reduced.

Time Saving Tool for Punching

By J. A. Luther

To overcome the changing of dies for punching different sized holes a movable die plate with six die holes of different sizes is used. A set screw then locates the die holes exactly under the punch, by fitting into a concaved indentation.

In the accompanying sketch is shown a time-saving device of some merit, when holes of various sizes are to be punched in structural steel or other materials. Instead of having only one die in the bolster, as is shown in Fig. 1 and was the old way, a gang of dies is used, as shown in Fig. 2.

To demonstrate this, six different sized holes are called for in the plate shown in Fig. 3. Accordingly, after one size of hole is punched, one must change dies to the next size and so on until the six changes have been made. Considerable time is thus lost in making the changes, as well as in hunting for an occasional misplaced die.

In making the multiple die plate shown in Fig. 2, a piece of tool steel is machined to the desired size. The six holes are then drilled and these are counterbored for the six dies; all of which have the same outside diameter. A different sized hole is drilled and reamed in each die, and the dies hardened, before they are put in the plate as shown; these holes being, ¼, 7/16, 13/32, ⅜, 5/16 and ¼ inch respectively.

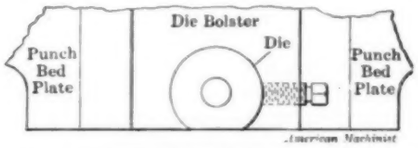


FIG. 1. PUNCH BED PLATE WITH DIE BOLSTER AND DIE

The die plate is dovetailed, as shown at *B*, in the end view, and in line with the center of each die, at *C C*, concaved indentations are made as shown at *D*. These are locating holes for set screws. The die plate slides into the dovetail on the bolster, as shown in Fig. 4, and this is bolted down on the bed plate of the punch press in its proper location.

When a certain size of hole is wanted, set screw *E* is loosened, die plate is slid over in line with the center of the die containing this hole and the set screw is then tightened. On account of the indentations located at *C C* and *D* (Fig. 2) the dies will find their own center and line up with the punch without any loss of time.

In punching angle irons the die must be high enough at *F* to allow the fillet in the corner of the angle to clear the corner of the die plate. From the center of the dies to the side of the die plate, at *H*, should be made as small as possible so as to take in the smallest angle iron. In the shop where this was designed and used, three die plates are used that contain three sets of dies of various sizes. The first set takes in dies from ⅛ to ⅜ inch inclusive, the next from 13/32 to ⅝ inch inclusive, and the next size from 21/32 to 1 inch inclusive.

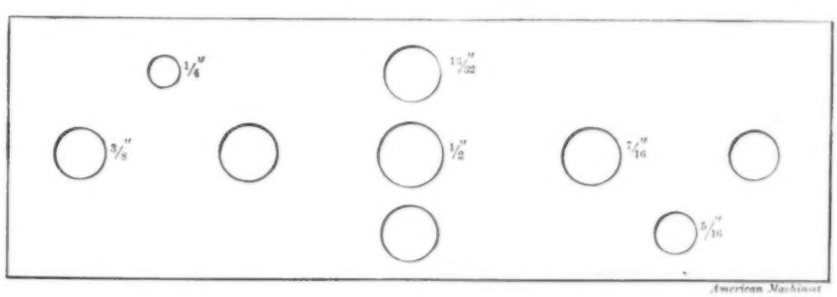


FIG. 3. PLATE PUNCHED WITH DIFFERENT SIZED HOLES

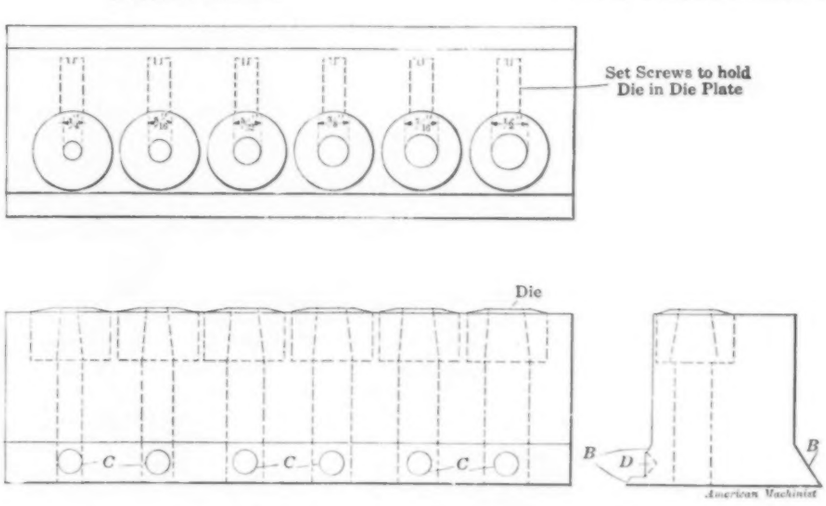


FIG. 2. MULTIPLE DIE PLATE FOR DIFFERENT SIZED HOLES

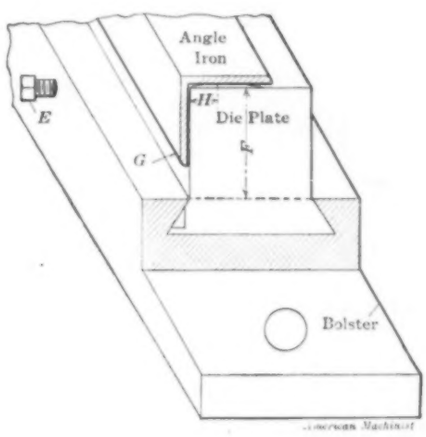


FIG. 4. DIE PLATE SET IN BOLSTER

Data on the Use of Broaches

Editorial Correspondence

Information about cutting allowances per tooth, number of holes broached and results secured in practical work.

The accompanying halftone illustration, Fig. 1, shows the type of press used extensively by a prominent manufacturing firm in broaching finishing holes. On the end of the press can be seen a worm wheel, near it its bearing, and a little to the left a set of broaches and the corresponding limit plug gages. The broaches and gages are for the holes in the worm wheel and bushing respectively.

Turning to the other illustration, Fig. 2 shows the broach and limit plug for the worm wheel, both drawings fully dimensioned, and Fig. 3 shows, similarly, the broach and plug gage for the bearing.

In broaching the bronze worm wheel, a roughing broach will do about 1000 holes with three honings. The finishing broach will do from 500 to 1500 and must be honed for about every 100 holes. The limit on these holes is 0.0003 inch and the broaches must be honed much oftener

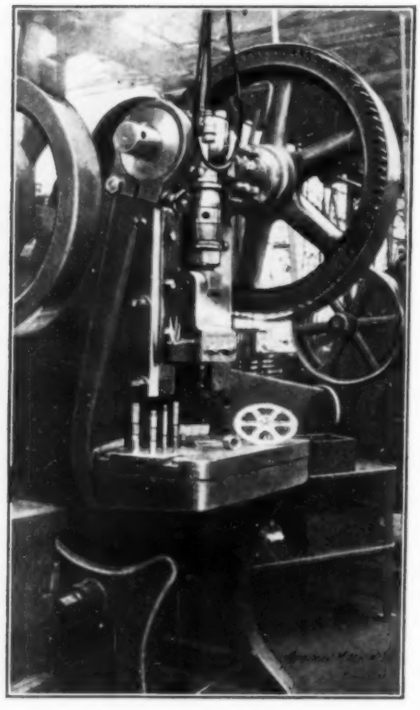


FIG. 1. PRESS USED FOR BROACHING AND SOME OF THE PARTS AND TOOLS

when used on holes with such small limits, than if the limits were larger.

BROACHING BRONZE BEARINGS

In broaching bronze bearings, one roughing broach will finish 3000 holes or upward, and the broach must be honed for every 1000 holes. In finishing, a finishing broach will do from 1000 to 2000 bushings and must be honed for every 400 to 500 holes.

If the walls of the bearing are thin, the honing must be done somewhat oftener because of the tendency for the walls to spring a little when the broach is forced through.

The finishing broaches, after they have become too small to finish holes within the required limits, are reground to roughing sizes.

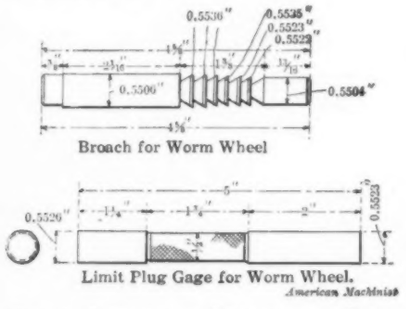


FIG. 2. DETAILS OF BROACH AND PLUG LIMIT GAGE FOR HOLE IN BRONZE WORM WHEEL

An experience with another shaft bushing is of interest. Formerly these bushings were reamed, but caused considerable trouble, as the walls are very thin, about 3/32 inch. Because of this thinness it was deemed better to ream than to attempt to broach, but in reaming they heated very rapidly and expanded, so much so in fact, that when they were cold the contraction brought the holes too small. It was then necessary to attempt to ream again in order to bring the holes to the exact size and the reamer coming in contact with a partly glazed reamed surface, heated the bushings more rapidly than before and the same trouble was present. At length an attempt was made to broach them, and this was so successful that it is now standard practice. A finishing broach does about 1000 holes and a roughing broach the same number.

On another bushing, with somewhat thicker walls and not to a close limit, a finishing broach does 3000 to 4000 pieces and a roughing broach 5000 pieces, without honing. In these cases the roughing broach finishes the hole to the size of the pilot on the finishing broach.

BROACHING CAST IRON

In regard to cast iron, this firm is now broaching cast-iron pinion-shaft bushings, after these bushings have been drilled and grooved with oil ways. In reaming these bushings, considerable trouble was experienced because a reamer blade entered the oil groove and thus made a slight ridge on the opposite side. Broaching has entirely done away with this difficulty.

In broaching cast iron, however, it has been found that it cannot be done successfully if there is much stock to be removed, for the cast iron has a tendency to stick to the broach and thus rough up the holes.

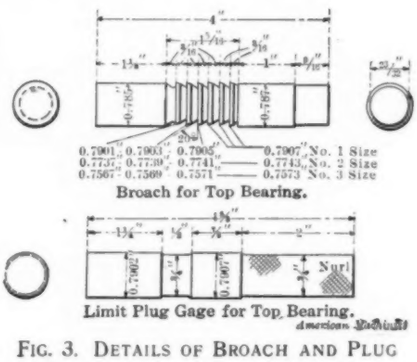


FIG. 3. DETAILS OF BROACH AND PLUG LIMIT GAGE FOR HOLE IN BRONZE BUSHING

In honing the broaches, use a Lily White or some other hard oilstone that will not wear rapidly into grooves and thus round over the cutting edge of the broach.

The broaches are ground with about 0.004 inch to hone to finished size so as to get a smooth, keen, hard edge. It is necessary to make the broaches a little larger than the finished size of the hole; this difference, of course, being greater for pieces having thin walls than for pieces with thicker walls.

An electrical process for treating waste oil pools in California, which at present are valueless, owing to the large proportion of water which the oil contains, has been patented, according to the *Electrical Review*, which, from experiments, is reported successful. The material to be treated is an intricate mixture of oil and water; subjecting this to the influence of a high-tension alternating current results in the minu water particles agglomerating and sink ing. The treating apparatus is essentially a huge Leyden jar whose disruptive discharge penetrates the oil film and allows the water particles to run together. In practice an alternating current is stepped up through a transformer to about 10,000 volts. The oil is delivered to the treater and passed on to the storage tanks, the precipitated water being carried off at the bottom.

The Story of the Artisan School

By John E. Sweet

The fundamental aim to make good workmen and better men of boys to whom a book education would be of little profit.

Made product to sell and placed boys on regular apprenticeship scale of wages.

Principal conclusion from the experiment: A boy or girl can learn any trade in a school.

In response to a request by the editor of the AMERICAN MACHINIST for a report on the results of the Artisan School experiment, I have to say that to fully understand the conditions, it is necessary to bear in mind that the school was established for the express purpose of training workmen on the part of those who furnished the money and on my part in the hope that we could take boys who would never get any profit from an education and make out of them good workmen and better men than they otherwise would be. This, it will be understood, was an entirely different aim from that of making educated mechanics with the implied promise that they would become foremen, superintendents or office men; that is we aimed to make trained workmen rather than educated mechanics. I had hoped to find a lot of boys from the grade school, who either could not or did not want to go to the high school, but did want to do something or, particularly, get where there was machinery and where they could help make things. This did not turn out quite as I had hoped, not but that we got enough boys but of the city boys we got only those of foreign parentage, which was also true of those from the country. Notwithstanding this discouraging feature, we learned that we could easily make a salable product and sell it. This was helped by selecting a good thing to begin with—machinist's vises—and this selection was good in three ways:

First, we wanted vises for our own use, second, no one was putting on the market vises made like machine tools, and, third, the way our vise was designed it called for the use of every machine tool we had in the shop and required various operations—drilling, countersinking, counterboring with jigs of the boys' own make, planing, shaping, milling, grinding, chipping, filing and polishing, lathe and hand turning, screw cutting, tapping, ball turning and riveting. All this in making vises, which were made well enough to sell at prices higher than the best standard makes.

PAYING THE BOYS

At first we did not pay the boys or charge a fee, and while we got applicants enough and plenty to start in, they soon fell out and it seemed that it was because they did not get what they wanted as apprentices in a shop. So, after the first trial, we changed our plan to paying the regular apprentice wages for seven hours a day for five days a week and four hours Saturday with one hour a day in the school. In addition to this we visited the various shops in the city Saturday afternoons. This, after we got well going, held the boys and gave us something of a waiting list. Everything was different from every other school as far as I know. In the drawing room there were no books. Every drawing the boys attempted to make was from the thing itself. We did not attempt to make draftsmen, but simply to get the boys to learn to read the drawings and to learn the relation that existed between the drawings and the things. The most of them learned in a short time to make fairly good drawings and of things of various degrees of complication, and this relation between the drawing and the thing was of more use to them than such instruction as the Scranton or schools of that kind can give.

REPAIRING SECOND HAND MACHINES

As time went on, we not only designed and made patterns and jigs for other tools and machines, which have been shown in the AMERICAN MACHINIST, but did what I believe was better for the boys than anything that could have been found in any school or commercial shop in the country. We repaired from 80 to 100 second-hand machine tools, ranging from Warner & Swasey turret machines to an oil separator and a wood-boring machine. It would occupy too much space to enumerate them all; but among the lot was a 24-inch Bullard lathe, Pratt & Whitney lathes and screw machines, Garvin screw and milling machines, a Cincinnati milling machine, a Whitney hand miller, Norton and Gardner grinders and wood and iron planing machines. We made surface plates, angles and straight-edges as perfectly as anyone. We did not intend to do tool making, but did as much as we needed, or as it would have been good policy for our own use. We did not want the boys to make everything by jigs, even had our work been the best for that system, believing that if they could do the work in the old way they could do it with jigs without learning. This repairing second-hand machines was a good thing for our boys, but would be better still for a class in machine design. It was even a consolation to me to prove so emphatically wrong the things I have been fighting against for the last forty years, but the discussion of this is outside the school question.

WHAT WAS LEARNED

Our boys were from 17 to 21 years of age and the things we learned were that we had to pay the boys and that they could earn just as much more as we paid them. For younger boys, possibly some other influence except money may do. We learned that we could make a salable product from the start and sell it; that as we went on, we could reduce the cost of running, as could well be expected, and undertake better work, and so much it seems to me is worth while for the world to know.

The experiment was in no sense a failure, and should be carried on by some younger man. I found my strength fast giving out; in fact, for the six months since we stopped I have been an invalid, but have lost no faith in the belief that a boy or girl can learn any trade in a school, if the school is made for that purpose.

The greatest consolation we get out of it is knowing that such of the boys as wanted them have good positions in various shops and all, I believe, are doing what they would in the same shops had they spent 50 per cent. more time there than in the school. One who had only eighteen months in the school is working as a journeyman at journeymen's wages and holding his position.

Hardened Copper

Every once in a while we see a notice in the papers that the lost art of hardening copper has been rediscovered. This is all nonsense. Before you can lose anything you've got to have it, and the ancients knew less about hardening copper than we do. The so called hardened-copper implements of the ancients were not copper but bronze, and our metallurgists know how to make more kinds of hard and soft bronzes than the ancients.

Their bronzes were probably the result of accident as much as design. Their copper ores probably contained as impurities iron and arsenic, and the Phœnecians sent ships to the Tin islands, now Great Britain, to get tin, which was used as an ingredient in their *hardened* copper. Whenever hardened copper is mentioned it is invariably an alloy containing copper.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Which End of a Piece Should Be Made First?

Many automatic screw-machine jobs, after the first operation has been completed, require a second operation on the other end of the piece. The second operation is usually completed with the aid of a magazine attachment, or the piece is transferred to the hand screw machine. The latter is the usual method.

Fig. 1 shows a piece which was tooled up on the automatic screw machine to form for the thread and drill the hole, and the thread was to be cut on the hand screw machine. After the tools for the piece were all made, it was found impossible to produce it in this manner. When the piece was placed in the hand screw machine to be threaded, the chuck crushed the shell enough to make it about 0.005 inch out of round, and when the chuck was loosened a trifle to do away with this difficulty, the threading die caused the piece to turn in the chuck.

The mistake made in tooling up this piece is a very common one on this class of work, that is in trying to do the long

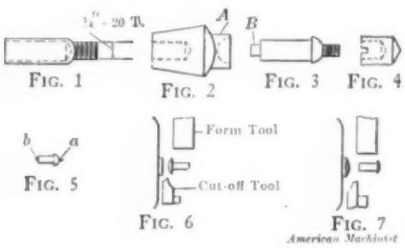


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

SCREW-MACHINE WORK

operation on the automatic. This piece was later made successfully by threading on the automatic, and drilling the hole on the hand machine, and it was found that the chuck had not injured the thread in the least.

Had it been required to box tool the body of this piece to a very smooth finish, instead of drilling the hole, the first difficulty would have been encountered in this case also, as the hand machine chuck would mark the bright surface, owing to chips, etc.

In making the piece shown in Fig. 2, it is desired to form the body and drill and tap on the first operation, leaving only the cupping of the end to be performed on the hand machine. This arrangement failed to work, because the tapered body kept slipping from the chuck, and as a special chuck was too expensive to make, owing to the piece not being a regular product, the piece was successfully made the other way around, being held by the pilot *A* while being drilled and tapped, the cupping being done on the first operation.

Fig. 3 shows a piece which we tried to make by forming the whole length except the threaded part, which was box-tooled. The work broke off at the small diameter *B*. The piece was later made in two operations, the small diameter being formed on the second operation. It might be well to add that a good rule to adopt is never to form with a tool whose width is more than twice the minimum diameter to be formed.

The operations for the screw, shown at Fig. 4, on the automatic were, feed stock, cut-off and form, and thread. The slot was cut with the slotting attachment during these operations, and the hand-machine operations were, center, drill and tap. The piece was made in this manner to take advantage of the slotting attachment with which the automatic was equipped. It was found, however, that the cost for the hand-machine operations was about 30 cents a hundred, while the slotting alone could be done on a hand-slotting machine for about two cents per hundred, and the other operations completed on the automatic with a great saving in cost.

The rivet, Fig. 5, is of soft iron and is made with the head away from the chuck. This is done to allow the cut-off tool to remove the bur at *A*, and causes it to appear at *B* instead.

I think that the best method to make these rivets is as shown by Fig. 6, as the bur on the head will be slight if the cut-off tool is kept sharp, and the cost of polishing off the head is small, whereas, if the rivet is made with the head out, Fig. 7, the cut-off tool must start cutting on the slender diameter. Consequently, to prevent the piece from breaking off, we must gear the machine low, causing a loss in production.

Cleveland, O. S. H. BACON.

Lining Up Engine Pumps and Compressor Cylinders

The lining up of cylinders on large pumps and compressors may be accomplished by a simple apparatus which may be quickly made in any shop. The essential parts are two uprights, a length of fine linen fish line, and several sticks with pins driven into the ends.

As shown in the figure, the uprights are constructed of a strip of ½-inch iron, 4 inches wide and 3 or more feet long, according to the hight of cylinder above the foundation; and a piece of wood an inch thick, 4 inches wide and 10 inches long, having a saw cut about 7 inches long and a ½-inch hole bored close to the other end. The iron strip has several ½-inch holes bored about 2 inches apart, at one end, and the other end bent up at right angles forming a foot for the bar to stand upon. A hole for a bolt to fasten the foot to the floor is bored in that end.

The two uprights are set up at opposite

STANDARD FOR LINING UP CORD

ends of the line of cylinders, and the fish line drawn through them is fastened to the uprights by tying it to short cross-sticks and allowing it to pass through the slots in the uprights. The twisting of the cross-sticks tightens the string. By the use of sticks of wood with pins driven into their ends, the string is located in the center of one of the cylinders. In this operation the stick acts as a radius of the cylinder, and by using points on the circumference at several places along the bore, as centers, the string may be located in the center of the cylinder and parallel to its bore. The uprights are adjustable so that the string can be easily moved to accomplish this end. By a similar process it is easy to tell when the second cylinder is on a line and center with the first.

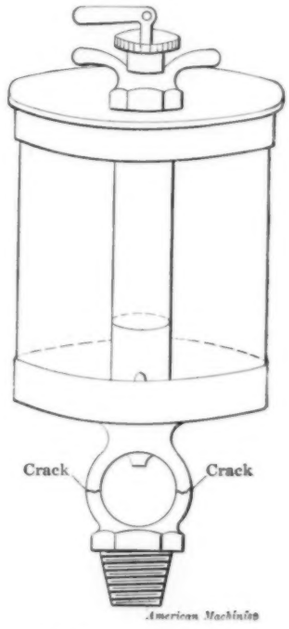
SIDNEY K. EASTWOOD.

Detroit, Mich.

Peculiar Breakage of an Oil Cup

A sight-feed oil cup of standard make had been screwed into the cap of a bearing of 1¾-inch shaft on a horizontal boring machine. This shaft was one of the gear drivers, the machine being motor driven. Owing to the bearing becoming heated due to the high speed of the gear, the operator had slackened the screws of the caps, allowing the shaft to turn more easily and the cap to have a slight movement.

About two months after this the top part of the cup was found on the floor broken, as shown in the cut, apparently by a heavy blow. The foreman claimed that the operator must have struck it a blow, but an examination showed that any blow strong enough to break the



A PECULIAR BREAK

brass would damage the glass and the glass did not show a mark. A new oil cup was substituted and the same thing happened. No one could explain just why it broke and it was decided to watch the third oil cup closely. In about two weeks a tiny crack was discovered in the brass, working from both sides toward the center. In another two weeks the crack had advanced at a little faster rate. After the cup had broken off someone suggested that perhaps the vibration of the cap had something to do with it. This was easily remedied, paper being placed between the upper and lower parts of the bearing and the screws made tight. Since that time (about a year ago) it has not given trouble, and there is a little better feeling between the foreman and the operator because each knows the reason for the cup breaking.

Brooklyn, N. Y. GEORGE MYERS.

A Balanced Change Gear Quadrant

In medium heavy lathes when using a quadrant, it is often a strain when a train of wheels is on the frame, to adjust it. Figs. 1 and 2 show an arrangement to assist this operation. The quadrant A,

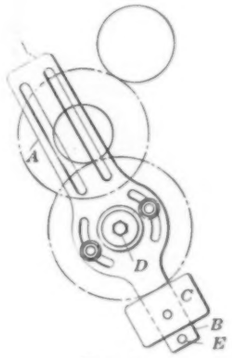


FIG. 1

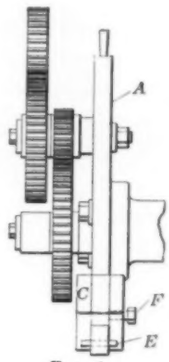


FIG. 2

A BALANCED QUADRANT

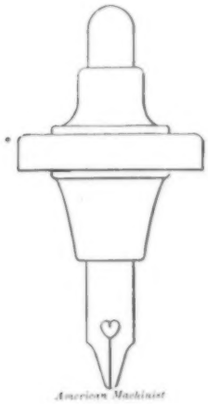
has a projecting piece B, on the opposite side of the pivot D. A balance weight C, is fastened on this piece B, can be adjusted on it and then fastened by the screw F. The pin E is to prevent the weight from slipping off. This weight helps to balance the quadrant and wheels and so makes it easier to adjust.

Manchester, England. W. R. O.

A "Tip" for the Ink Bottle

In many drawing rooms the draftsmen use small ink bottles which are frequently refilled from the larger bottles in which the ink is purchased.

These small bottles are thus used for



A TIP FOR THE INK BOTTLE

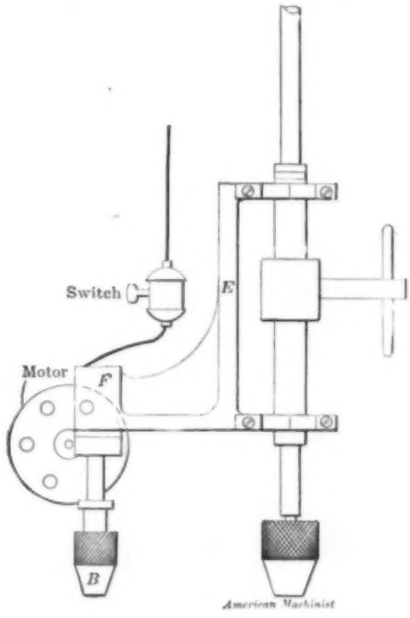
a long time and the quill which is attached to the stopper becomes soft and sometimes broken so that it will not reach to the bottom of the bottle.

The broken quill may be cut off close to the cork and a large stub pen inserted so that the point will reach the bottom of the bottle when the stopper is in. The filler will then be as good as with a new quill and will last longer.

Bowling Green, Ohio. W. H. K.

Rigging an Extra Motor-driven Spindle on a Sensitive Drill

The following rigging in combination with a sensitive electric drill I have had on my drill press for some time and find it very handy on small work where tap and clearance sizes are to be drilled in same piece before removing it from jig. A suitable bracket E is clamped to the quill of drill press. The electric drill used is provided with a stem projecting from the gear case (which normally



THE RIG

holds the handle). This stem is fastened to the bracket E at the joint F. The switch is clamped to the bracket at the position indicated and can readily be operated for starting or stopping the motor.

New York. R. C.

Heard in the Shop

The boss ordered one of the laborers to plant a pole in the ground outside the shop for some purpose the other day, and when he had finished he told the boss and the boss asked him if it was plumb. The laborer said: "Oh, yes, it's dead plumb and a little over."

When the whistle blew at quitting time the other day, one of the boys said: "It don't take all that noise to make me stop work."

Baltimore, Md. F. E. FICK.

Discussion of Previous Question

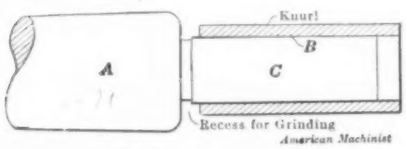
Locating Holes Accurately on the Milling Machine

Mr. Murdock's indicator described on page 337 certainly is a good one, and he deserves credit for sticking to a problem which so many men have given up as hopeless.

It is really surprising how many men are working on that same problem.

Some day I hope an indicator will be discovered that will meet the demand. When it is, milling-machine stock ought to advance a couple of points for there are many jobs the poor old lathe has to swing to because of our inability to bore them accurately as to location on the miller.

Owing to our inability to locate a point with a prick punch closer than, let us say



LOCATING HOLES ACCURATELY ON THE MILLING MACHINE

0.0015 or 0.002 inch, Mr. Murdock's indicator, therefore, will not give us a closer measurement than these figures. Of course, there are times when we come closer than 0.002 inch but then again there are times when we don't. And this element of uncertainty makes the use of the prick punch location a dangerous proceeding on work where accuracy is essential.

We all know how uncertain the center indicator is as used on the lathe, therefore we cannot expect any better results on the miller. Nevertheless there are many jobs that Mr. Murdock's indicator will be suitable for.

In the cut I offer an idea which has proved a good friend to me and I feel more confident in using this method than the others in use.

The device consists of the tool steel, hardened and ground arbor *A*, the shank end *C* being lapped as well as ground. The sleeve *B* is also of tool steel, hardened, ground and lapped to fit the shank *C*. A set of buttons which are of the same diameter as the shank *C* must also be made. To use the tool; button the locations in the usual way, strap the job to the table of the miller, insert the device in the spindle of the machine and bring one button as near as possible to "position" and try to slip the sleeve of the tool over the button. Providing the tool is accurately made and the buttons fit accurately in the sleeve, this will be impossible to do unless the button is in correct position. And correct position can only be got by adjustment of the table and knee.

If your miller is in good condition and the taper spindle is not full of lumps and dirt it is possible to work well inside 0.001 inch.

Two of these tools, one with short shank *C* and sleeve, the other with long shank *C* and sleeve, make a combination which will cover most all the ordinary work.

Shank *C* and sleeve *must* be lapped to a close fit. Yet the sleeve must be loose enough to admit of being slipped (with a slight wringing action) along the shank.

The closer they fit and still allow of this action, the better the tool and the closer the work.

Newark, N. J. JOHN MELVILLE.

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Grooving the Spindle Nose

In a recent issue of the AMERICAN MACHINIST, I noticed an article on grooving the lathe spindle to remove dust and such chips as may get in the threads, making it difficult for the chuck to pass on the spindle freely. The writer has noticed time and again that one man out of ten will force the chuck upon the spindle without removing the cause.

The result is that the chuck will not run true. The better mechanic will not stand for that; he will either use his scribe or use some makeshift to remove the chips. I cannot see why the groove in the spindle should be an objection or why the employer should refuse to have it. It is certainly a time saver. It is not necessary, at all, to groove the spindle the entire length, but just cut a groove over two or three threads with a three-cornered file. Then if the spindle does not enter freely, remove the chuck, brush out the chips and dirt that have gathered in the groove and try again until spindle does enter. After that you will never have any more trouble with the same chuck.

WILLIAM F. HOFFMAN.

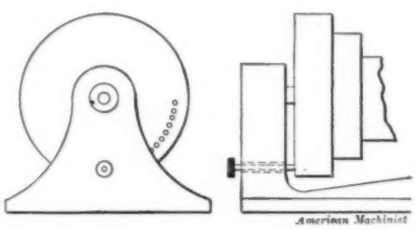
Detroit, Mich.

Indexing on the Cone Pulley

On page 224, is illustrated and explained a device for indexing on the cone pulley of a lathe. In this connection I desire to present a different method of applying the same principle and which has proved entirely satisfactory on the metal lathe in our pattern shop.

Instead of the index holes being on the face of the cone, we drilled them on the end. The pin is made and operated in the same manner, but is placed in the end of the headstock and in line with the circle of holes. With this arrangement it is unnecessary to have a bracket which requires to be removed when not in use.

We have 72 holes, which provide for the variety of divisions most commonly



INDEXING ON THE CONE PULLEY

used. Should other divisions be desired, a split ring, made of sheet brass with the required holes, can easily be made and fastened over the original circle of holes.

Lead, S. D. S. J. S.

Confessions of a College Professor

I was much amused at the so called "Confessions" and more so at the defenses which have been forthcoming from pupils of the much abused "dear teachers." With all due respect to the profession I believe the confession comes much nearer confessing than most of them.

Here are two cases I know of in institutions of national reputation.

The new professor had been used to doing a real week's work in commercial manufacturing and so when he only had to work 20 to 25 hours a week he naturally thought he had an easy time. But the other professors soon showed him that he was working overtime and full fledged professors' union couldn't have acted more in unison in expressing their disapproval of his conduct. But when a man can have from three to five afternoons a week to play golf, do outside engineering

and other things, he can hardly be accused of burning the cards at both ends on the professor's job.

The other case was where the manager of the football team was shaky on geometry. Examinations were due and the wise ruling of the faculty made it absolutely necessary for all athletes to be good scholars. But the "honor" of the college depended on the manager being on the job as the professor asked him if he didn't know a few theorems he could recite as an exam.

"Not a blamed one, Prof."

"Well you have a good memory. Learn two theorems and come here early tomorrow morning."

So in the solitude of the classroom, Mr. Manager recited two short memorized theorems and was marked as having passed. A marvelous object lesson in the integrity of the profession and the value of a solid foundation in the useful studies.

I agree with the ex-professor that most of them get all they earn, and they could easily do much more and should be paid according to what they earn, the same as the rest of us. I believe that the number of men could be much reduced, salaries increased to some extent with a total saving in the cost of instruction that would help put many struggling institutions on their feet.

Chicago, Ill. FRANK C. HUDSON.

The Buying of Machine Tools

Referring to this question written about by Mr. Osborne, and then by Mr. Allen, the writer believes that both of these gentlemen have spoken of the reason why the best machine tools for the purpose are hard to pick out, without apparently noting the fact. In the writer's opinion, the reason mistakes are so often made is because the tool itself is not seen and investigated, but judgment is too often based on some salesman's talk.

There are many reasons why a buyer will not buy direct, especially when he is buying an outfit of tools, but wherever it is possible the buyer should visit the shops of the manufacturer. It is a foregone conclusion that the man who does the visiting should be the best man in the works for the purpose, and should be the one who is looked up to to make good. In order not to take the buying privileges away from the office, he need not commit himself, but should report his observations to the office for action.

Is there any question but that this man would pay for his trip in the knowledge he would derive from the shop practice in the plants he would visit? These plants would show him just how they did their work, and why they did it; show him their jigs and special tools, and samples of their workmanship and design that would go far, not only to show him the best tool to buy for his purpose, but how a great deal of his work could be done to better advantage. In other words, to use a slang expression, be from Missouri.

The first point Mr. Allen speaks of is belt pull or theoretical power. The real point to consider is, as he says, whether the tool is rigid enough to stand the strain that would be put on it. If one could learn the relation of the actual cutting power of any machine tool to its belt pull or initial power, he would have something tangible to base his judgment on. The loss of power from the drive to the cutting tool is nothing but friction, and any excess loss is excess friction which is demanding compound interest many times over. It's in the power bill, it's in the wear and tear and breakdowns, and it's in loss of efficiency. Where a machine can be tested with a motor drive it is easy to arrive at its efficiency in this respect.

There is another way. Most tools of the same type and size, especially those of equal cost, are designed much alike as to belt pull; there may be a slight difference in belt contact per minute which can be allowed for. Then is it not evident that the one that will stand up solid under a heavy cut is the most efficient, or in other words, the one that will take the biggest cut under the same conditions? As Mr. Allen says later on, it's the strongest tool, and the writer would say, the one with the largest bearings, not necessarily the greatest dimensions, as the capacity of the tool usually governs its dimensions. Don't forget that there is a lot of overhang in machine tools, more in some than in others, and where this overhang cannot be eliminated, it should be offset. A well known example of this is the table of a shaper, the overhang being offset by the table support. Where this overhang is in the running parts, as in the bull gear of a crank shaper, the difference in power required to take a cut, as between a poor and a well designed machine is very great.

There can hardly be a question but that the machine tool that will stand the heavy cuts without distress will also stand fast speeds, and the one that will stand the heavy cuts and fast speed is the durable one, because it must be well built and properly designed to stand the strain. Another point is, that the tool that is rigid under heavy cuts and fast speeds has the proper design for accuracy. Workmanship on any tool is perhaps the most important point, as good workmanship on a light tool will produce accuracy, but where roughing and finishing is done on the same tool, then that tool should have all the requisites of permanent accuracy, and a light tool cannot be expected to work to its capacity and yet retain its accuracy.

Most people think because a machine tool is slightly heavier than another that it will be much harder on the operator. It is true to some extent that a large capacity machine of the same make is harder on the operator, but a large machine of one make may be easier to handle than a small one of another make. It is ridiculous to claim that 25 per cent. more weight nicely distributed would make the operator any more work on a drill, a shaper, a lathe, etc., but the general impression is that a heavy tool is slow and awkward to handle.

Claims based on weight alone are very misleading too, as it is a mistake to go away beyond what is necessary. Cast iron is cheap and, to avoid misunderstanding, I want to repeat that it is the generous bearings well supported that make the durable tools, and it makes the costly ones to build also. Frills or mere talking points should not be considered at all, but any feature that has real mechanical excellence over another, or adds to the easy operation of the tool without being trappy, is worth while considering. The operator's time in making his setting and getting his adjustments when making changes all go to make up points to consider.

All these points can be summarized into a few features; granting that dimensions are the same on tools of the same rated capacity, such as the vertical and cross traverse of a shaper, size of vise, keyseating capacity, etc., then the features that must be considered are accuracy, convenience, durability, power and speeds. Sometimes all of these features do not have to be considered. In the writer's business a great deal of planing is done. This planing is almost entirely on cast iron, the patterns being made just to allow the necessary finish, and it has been found that these planers have more power than is absolutely necessary, and as only one speed is used, the last two features mentioned above are not important on these planers, but the first three features are all very desirable. On lathe work, where the diameters vary, as does also the hardness of the material, and on the shaper, where the length of the stroke varies the speed of the tool, a good range of speeds is required to do rapid work.

All manufacturers get out printed matter designed to appeal to the buyer, but how many of these catalogs are read or compared with others, and the tool bought on conclusions thus formed? A slightly better way to buy is to have a salesman call and go over the points of his tools, but many times this salesman could not operate the tool and can only repeat what he has been told. The only safe way is to have the two mechanics get together, the one who is to use and the one who builds, and it is evident if this is done a great many more tools will give good service on the work than are at the

present day. No dealer has the best tools of every kind, and there are some tools that are in a class by themselves, so it follows that the man who buys all his tools from one dealer will pick up an inefficient tool now and then. Don't take anyone's word for it. The manufacturer who is proud of his output will welcome you with open arms.

A. M. WATCHER.

Queen City Machine Tool Company, Cincinnati, O.

The Large Shop Order

In regard to your editorial, page 797, Volume 33, Part 1, on the large shop order, I give you my analysis of this question as it applies to our factory.

We have in process of installation a new order and follow-up system which bids fair to be the best thing in this line which we have even seen. For the past two years we have been endeavoring to keep our stock in better condition. It would seem that to do this we would have to anticipate what the salable sizes were going to be for the coming month in order to get the stock along to meet this. The demand for different sizes and kinds of drills varies as much as 50 per cent. for different months, and seems to bear no relation to anything on which an estimate can be made. It is obvious that this fluctuation leaves some sizes overstocked and some considerably short. We use the average sales per month for the last six months' period to base orders for the coming month, dropping the first month and adding the month just finished. This method does not take care of a spurt or a sudden collapse in business, as is evidenced by our having had a four-year supply of drills of one particular size cleaned out in five weeks and being behind 130,000 drills of another size at the end of a month. Of course, we do not think any system would take care of these kinds of spurts.

After a careful analysis of the situation, I came to the conclusion that our stock orders were too large and that they took entirely too long to get through the factory. In fact, your editorial just about hits the situation here, except that I did not find any proof that large orders were conductive to more accuracy of product. In our business any stock order is large enough to get the machines set up with accuracy, but the human factor enters into the question in extremely large orders through the tendency of inspectors to take for granted that the work is O. K. because the previous day's product, which came from the same set of machines, was up to standard. In other words, I find the same thing going through too long a period breeds carelessness on the part of operators and inspectors.

My investigation also showed that the extra cost of set ups by cutting down the size of lots was more than offset by the cost of letters, which had to be written making excuses for delayed shipments because of the interval between the arrival in the stock room of the large orders. Also the heavy demand for a certain size drill necessitating the splitting of orders to hurry a part of these through. This meant considerable extra clerical work to hunt up the shop orders and change the promises. It also increased clerical work in the pay-roll department to keep track of divided lots. We find that the time per piece through the factory is much larger in large orders than small ones. We also find that large orders are a great handicap in getting out specials in any kind of reasonable time, because we wait for the completion of a lot, in a large number of cases, to run through the specials to save set ups.

A comparison I made in favor of small orders was to liken the travel of the product through the factory to a railroad between New York and Chicago. It is just as sensible to think this railroad would try to haul all the freight per month on one train from New York to Chicago as to suppose any one would attempt to run a month's business through the factory on one order.

The comparison seems fair because the railroad is limited to what can pass each other on the tracks, and the factory is limited to what can get through without interference in the machines. Therefore, the proper solution would seem to be to keep the tracks and machines occupied all the time with smaller trains and orders, but keep a steady stream on the move.

Our new system will be likened to a railroad in another respect. Every stock and special order will be routed through the factory, due to leave on a certain day, just the same as trains are due to arrive and leave a station at a fixed time.

The operation of this system entails a tremendous amount of calculation and preparation to be able to do this without confusion. This can be readily understood by the statement that the capacity for every piece of work each machine in the factory is capable of doing must be taken into account and all promises made according to this capacity.

Cleveland, Ohio. E. C. PECK.

Flats on Hobbed Gear Teeth

Walter G. Groocock's article on page 411 should not be allowed to pass without comment, and in my mind, David H has widely missed his mark. We trust that Mr. Grant, after he recovers from his narrow escape, will let us hear from him further on the subject.

It seems that Mr. Groocock has entirely overlooked the fact, to quote from Mr. Grant's article, page 1148, Volume 33, Part 1, that "the hob tooth reaches the true surface of the tooth it is cutting only when it reaches the center of the tooth space, and it can thus center only when it is at the common center line, the line that is normal to both the axis of the gear and to the axis of the hob."

Mr. Grant has illustrated his statements with a single fly cutter passing through a thin disk, which represents the full depth of the tooth, and converting this into a series of disks, as Mr. Groocock has suggested, will not alter the case.

After the hob tooth reaches its full depth, it draws itself from the cut, and any metal that is removed after the center is past, is simply stock that will be again reduced on the next revolution of the gear.

Mr. Groocock's theory will apply in worm gearing, as the hob tooth is constantly in the cut and the revolving of the gear and hob will produce the curves, as stated in his article.

The AMERICAN MACHINIST is held up in our shop as a source of information and the "Discussions of Previous Questions" are rediscussed with great interest.

All the fellows are waiting for Mr. Grant's return fire.

Pittsburg, Penn. K. P. ROLSTON.

How Can Twist Drills Be Hardened?

I shall be glad if some of the readers of the AMERICAN MACHINIST would answer the following.

It has been the custom of my toolmaker when hardening twisted high-speed drills to follow the steel manufacturer's advice and heat to a white (nearly melting) heat and then cool in a blast.

Finding the drills thus treated too hard, the process was supplemented by tempering, in which they were heated to a straw or blue, according to the judgment of the smith, and then thrown on the ground to cool.

Lately I have had these drills hardened with a gas furnace and I find that the hardening heat, previously adopted by the tool smith, was considerably above the recalescent point.

I am now wondering if that was the reason why it was necessary to temper the drills after hardening, also if the action and result are the same in the two following processes.

(1) A piece of steel is hardened at say, 2300 degrees Fahrenheit, and then raised to 400 degrees Fahrenheit and left to cool.

(2) A piece of steel is hardened at 1900 degrees Fahrenheit, which is 2300 minus 400.

Darlington, Eng. ROBT. DUPONT.

Classifying Metals for Machinery

By Walter J. Bitterlick

The different kinds of metals used in building machinery and the uses to which each can be best put. The comparative tensile and compressive strength of each, as well as their resistance to shock. The method used to form each into shape.

The properties of the different metals and alloys that enable them to be used for various purposes such as beds, frames, gears, cams, shafts, spindles, springs, rollers, journals, etc.

The selection of materials for machine construction ofttimes requires considerable study for the designer and draftsman, considering the fact of the numerous varieties on the market. If there is no classification before him, one particular kind may be superior to another and yet escape his memory, whereas, if he had a classified list, it would refresh his memory and enable him to quickly decide which is the better metal for each particular part. While opinions may differ considerably as to which is the best material, one could make a selection that would be suitable.

When building only one machine, the judgment of the designer is not required to be exact on the matter of cost, and two or three different metals, with but a trifle difference in cost, might be equally well adapted for use. When, however, machines are produced in hundred and thousand lots, the cost of one material over another would be such as to tax the judgment of the designer. There are also many draftsmen with a lack of sufficient experience to make good selections, and for these reasons a classification list would be useful.

Object of Classification

I will not attempt to treat the chemical properties of the metals. Mr. Tupper's article on page 534 of Part 1, Volume 33, treats the subject of steel very clearly, and I don't think it necessary to treat on the other metals for this purpose of classification. Mr. Tupper also classifies his steel for a wider range of use than I am attempting. My classification is only for general machine designers, with the idea in mind that auto design, tool design, engine design, etc., are in a class by themselves. There are few drafting rooms where the steel is specified in relation to its carbon percentage. If drafting rooms would adopt such a schedule it would tend to show a higher efficiency.

Material.	Tensile Strength.	Compressing Strength.	Shock Resistance.	Formed for Use by	Classes.	Uses.
Cast Iron	Low	Very High	Low	Casting	.....	Frames, Beds, Legs, Brackets, Gears, Cams, Uprights, Treadles, Clutches, All large parts.
						Bushings below 400 ft. per min. speed, Journal bearings, Heads, Levers, Caps.
Mal. Iron	Medium	.....	High	Casting	.....	Small complicated parts, Brackets, Levers, Pinion gears, Links, Where ductility is required, and lack of space. If more strength is desired use Steel Castings.
Wro't Iron	Medium	Medium	High	Forging	Rough	Misc. forgings, Experimental work, Truck parts, Straps, Treadle rods, Bolts.
					Cold Rolled	Shafts (stationary), Where accuracy of movement is not required.
Brass	Low	.....	Medium	Casting or Forging	Bronze	Bushings above 400′ per minute speed, Springs of hard drawn wire.
						Hydraulic machinery.
					Gun Metal	Heavy bearings, Bushes, Hydraulic machinery.
Bronze					Phos. Bronze	Cog and Worm wheels, Axle bearings, Bushings, Hydraulic machinery.
					Manganese " Brass	Worm wheels, Propellers, Hydraulic machinery.
						Handles, Handwheels, Wrenches, Thumb nuts and screws, Where appearances are desirable.
White Metal	Very Low	.....	.....	Casting	.....	Journals and Bearings.
Steel Casting	High	High	High	Casting	.....	Where strength is more desired in a minimum space; otherwise same as Mal. Iron.
Mild Steel — Bessemer Steel	High	High	High	Forging	C. R. Bess.	Connecting links, Stationary shafts and spindles, Pins, Treadle rods, Caps, Nuts.
					Bess. Rods	Connecting links, Treadle rods, Bracing rods.
Mild Steel — O. H. Steel	High	High	High	Forging	Machine Steel	Shafts, Spindles, Studs, Lever studs, Collars, Pinion gears, Slides, Caps.
					Key Steel	Can be substituted for Crucible Steel if case-hardened. Keys, Gibs, Uprights.
High-carbon Steel	Very High	Very High	Medium	Forging	Crucible Steel	Small keys, Studs, Cam studs, Taper pins, Spindles, Shafts, Shoulder pins, Lever studs, Outside studs, Where higher efficiency is required than the mild steels.
					Spring Steel	Flat springs, Coil springs.
					Music and Steel Wire	Springs, compression and tension.
					Drill Rod	Pins, Dowels.
					Tool Steel	Cam rolls, Pawls, Cam-roll studs, All parts with excessive wear.
					Stubs Steel	Dowels, Pins.
					Tungsten	Tools
					Mushet	"
					Silicon	" Springs.
					Chrome Vanadium	" Armor plate, Shells.
						Automobile parts, Parts to withstand vibrational strains.
					Chrome Vanadium	Automobile parts, Parts to withstand vibrational strains.
					Nickel Chrome	Automobile parts, Propeller shafts, High-speed machinery.
					Nickel	Automobile parts, Ordinance, Armor plate, Crank and Propeller shafts, High-speed machinery.
					Manganese	Crushing rolls, Gear sprockets, Where no machining is required.

CLASSIFICATION OF METALS FOR DESIGNERS AND DRAFTSMEN OF MACHINERY.

My main object in this classification is to enlighten the designer or draftsman. The selection of materials depends largely on the manner of forming for use, that is, forging or casting, and the tensile strength, comparative strength, shock resistance, and appropriateness for wearing surfaces. The cost depends on the judgment of the designer.

Friction Surfaces

The surfaces of machine parts that move over each other under pressure, are normally separated by a film of lubrication. Under exceptional conditions the metallic surfaces themselves may, however, come in contact. When this occurs the danger of roughening or destroying the surfaces depends upon the excellence of the surface and kind of material. The material may be well adapted for wearing surfaces because of hardness, slipperyness, homogeneousness, or because it is partly composed of lubricating material.

Thus hardened tool steel is difficult to roughen because of its hardness. White metal, though soft, is difficult to roughen, because the roughening agent slides over the slippery surface. Open-hearth, or bessemer steel would have less tendency to roughen an engaging surface than wrought iron, because the former has a homogeneous surface, while the latter carries streaks of gritty cinder; cast iron tends to wear smooth rather than rough, because it contains graphitic carbon, which is a lubricating material. Sliding surfaces in machines are often formed upon cast-iron members, and an engaging surface is also of cast iron. The frictional loss may be reduced by giving one surface a white metal covering, or steel may rub on cast iron, steel on brass, etc.

The more important materials used in the construction of machinery are as follows: 1, cast iron; 2, malleable iron; 3, wrought iron; 4, brass or bronze castings; 5, White metal, including all alloys for bearings, etc.; 6, steel castings; 7, bessemer steel; 8, O. H. steel; 9, high-carbon steel These are classified in the accompanying charts and the principal uses for each given.

Cast, Malleable and Wrought Irons

Cast iron can be used where shape, weight, mass and compressive strength are desired. In some cases portions of the outside surfaces may be chilled very hard, to resist wear, and thus eliminate the use of steel.

Malleable iron is like wrought iron in strength, ductility, resilience and softness. As it can be shaped by casting, it becomes very useful where space is at a premium, ductility is required, and the parts are so complicated they cannot be forged to advantage both in cost and working.

Wrought iron should not be used where accuracy of movement is essential or perfection of bearing is required.

Cold rolling greatly increases its elastic limit and strength, and produces a polished surface, but reduces its ductility. It may also be case hardened. It does not harden by suddenly immersing in water and is the most easily worked metal for the blacksmith. It is very good for experimental purposes, when it is desired to quickly demonstrate something at a minimum cost.

Bronze and Brass

Brass compositions are generally used where appearance is a consideration. Some compositions are strong and ductile and may be substituted for malleable iron or steel castings, but the high cost puts them out of competition for many purposes unless a steel foundry is not available for quick delivery and castings are wanted quickly. There are many compositions under this head, but the more important are: Gun metal, hard gun metal, phosphor bronze and manganese bronze.

Brass, bronze and other alloys may be used for springs, but usually in the form of hard-drawn wire with an artificial elastic limit.

The most important use for white metal is for journal bearings. There are many different alloys for this metal with only a small difference in their commercial value.

Low-carbon Steels

In classifying the different steels it is difficult to refrain from the use of commercial names, as all large concerns and most of their employees know the steels by these names only, and the designer and draftsmen almost always call for them in that manner on detail drawings. For this reason I classify some of them under the commercial names.

Steel castings are generally used the same as malleable iron, but when a higher tensile and comparative strength is desired. Some castings can be forged, welded, tempered, case hardened or oil hardened. Of course, there are different grades of such crucible, open-hearth, and bessemer-steel castings, grading in the order named. While the compressive strength is less than cast iron, and the tensile strength is greater than wrought iron, unlike wrought iron it is fusible, unlike cast iron it can be forged.

Bessemer steel is a soft and mild machinery steel. Some bessemer steels contain but little carbon, show but few characteristics of steel, and are but little better than iron. It is generally used where machine parts are not required to do much work.

Open-hearth steel is a better grade than bessemer and can be produced with any percentage of carbon. It is used on parts that are obliged to have greater efficiency than bessemer steel. There are many concerns that do not specify O. H. or bessemer on their drawings, but generally call for machine steel. As some firms, however, specify these, I have included them separately in the classification.

Applications and Characteristics of High-carbon Steels

These include crucible, sheet steel, music wire, steel wire, drill rods, stubs, tool, tungsten, mushet, silicon, chrome, vanadium, chrome-vanadium, nickel-chrome, nickel and manganese. There are other high-carbon steels that are somewhat equal in qualities, but they are rare and seldom used. I shall dwell on some of the characteristics of the more important of the above list and not attempt to cover them all. Crucible steel is most generally used when a higher efficiency is desired than can be obtained with open-hearth steel. Tool steels, which are under different trade names and comprise all high-carbon steels, are usually the best grades of crucible steel, but they are sometimes made by the O. H. process. They are generally the best steels to use in machine construction. Spring steel is best when made of crucible steel, as it has a higher elastic limit.

Manganese steel serves best where a grinding wear in dust is required. It has a high tensile strength, and is very hard, tough and ductile. It is the most durable steel where hardness and toughness are required. Its hardness prevents its use where machining is required. Tungsten steel is suitable for metal-cutting tools. It is self-hardening and fine-grained and very hard in the hardened state. Vanadium with chrome-vanadium steels exceed all others in their ability to resist dynamic stresses.

Nickel-chrome steel is generally used where price is sacrificed to obtain quality and is, therefore, well adapted to automobile work. Nickel steel, on account of its ability to withstand heavy shock and torsional tests, serves best in ordnance and automobile work.

Conclusion

In some cases I classify certain machine parts under more than one metal, as, for instance, studs are under O. H. and crucible steel. This, of course, would have to be governed by the amount of work required of the piece and would largely depend on the judgment of the designer. Another illustration in the selection of material would be in a pair of gears of a ratio of 6 to 1. The gear may be of cast iron, but the pinion, on account of one tooth acting 6 times to 1 on the gear, would be better if made of a machine-steel forging or a steel casting. There are many such cases that would depend largely on the judgment of the designer, in the selection of the more appropriate metal.

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American Machinist

Editorial

Progress in Industrial Education

We are in receipt of bulletin No. 11, of the National Society for the Promotion of Industrial Education, which contains a descriptive list of trade and industrial schools in the United States. We regard it as one of the most valuable of the Society's bulletins, as it gives in concise form the present state of development of industrial education in this country.

We have been especially interested in gathering from it a few figures showing the progress which may be fairly attributed to the discussion and agitation that has been going on for several years. Taking the year 1905 as a starting point, we have compiled the following figures from the pamphlet:

The schools listed and described are divided into several classes, of which the first is intermediate industrial, preparatory, trade or vocational schools, the chief object of which is to take boys and girls at about the age of 14 and give them some preliminary industrial work, including shop work, which, while not professing to teach them specific trades, will lead them in that direction and enable them to enter the trades two or three years later with advantage.

Since the date named we find that 12 such schools have been established, all of them being administered as part of the public school system, and supported at public expense, with a single exception, in which private enterprise carries a portion of the financial burden. In this class, the State of New York is easily the leader, with 12 schools; next comes Massachusetts with three, and Georgia with one—no other State being represented in the list. Of cities, Rochester, N. Y., leads with three schools, no other city having more than one.

The second class of the pamphlet is trade schols, in which the work is done in the daytime. Since the year named we find that 11 such schools have been established. Their distribution is much wider than the previous class, the figures standing: Connecticut, one; Massachusetts, two; Missouri, one; New York, three; Oregon, one; Pennsylvania, one; Wisconsin, two. Eight of the schools are administered as parts of the public school system and are maintained at public expense, the remaining three being maintained by private enterprise.

Class three relates to daytime technical schools, by which are meant schools of a more advanced grade than trade schools. Of these, but two have been established during the interval under consideration, one in Cleveland, Ohio, and the other in Boston, Mass., in both cases at public expense.

Class four relates to apprentice schools maintained by employers, in most cases individually, but in a few cases by united effort. Of these we find a total 39. Among the schools are those of the New York Central & Hudson River, and of the Atchison, Topeka & Santa Fe railroad systems, the former of which maintains 10 schools at different points upon its lines and the latter 22. The geographical distribution of the remaining schools is as follows: Connecticut, one; Illinois, one; Massachusetts, three; New York, one; Pennsylvania, one.

Class five relates to the evening schools of a technical and in some cases a shop character. Of these, counting one or two, that while organized prior to 1905, have been reorganized since that date, we find a total of 13, of which nine are supported at public and four at private expense. Their geographical distribution stands: Massachusetts, seven; Missouri, one; New York, five. The Missouri example is, of course, the David Ranken, Jr., School, which has already appeared in class two. This count does not include the Y. M. C. A. schools, as data regarding their date or origin are not given.

Class six covers the coöperative schools, which we do not here need to describe. Of these three are given, although the most recent example at Providence, R. I., has been overlooked. Of those given two are in Massachusetts and one in Ohio.

The above completes the list of industrial schools established during the interval under consideration, except for a correspondence school for the printing trade established by the International Typographical Union.

When we regard the extent of the country's need of industrial education, the above list is certainly not one to justify self congratulation beyond that due to the feeling that a real beginning has been made, and that the flood of discussion has at last resulted in something tangible. It will be seen that, so far as a count of the number of schools established is an index, the enterprise has accomplished more than that of public educators, and in real value the difference

is, no doubt, still greater. When we count employers instead of schools, however, we find a total of nine, which is too small to justify much more than the hope that it will increase.

Briquetting Chips

In Germany and Switzerland a process is coming into general use that deserves to be better known here. It is the briquetting of cast-iron and steel turnings. As practised there it is very simple, no binder of any kind being used, nothing but hydraulic pressure. There are several firms in Germany that are making a business of briquetting chips and in Switzerland a factory is now under construction, which is intended to serve for the entire eastern section of the country. It is stated that there is a net profit of about 75 cents per ton, in case the chips are purchased or figured at the usual market rate, briquetted and sold at the advanced price that they then bring. Foundries are eager to buy these compressed chips as they form a valuable addition to cupola mixtures.

In view of these points of advantage and the simplicity of the process, nothing being required but a hydraulic press and a mold, there seems to be no reason why it should not be generally adopted in this country.

Appropriating Credit for Others' Work

One of the most fruitful causes of discord in a shop or other institution is the failure of foremen or superintendents to give credit for new ideas, devices or helpful suggestions of any kind, where they belong.

Some foremen seem to feel that if an idea from one of the men gets past him to the manager, he will be blamed for not thinking of it himself. They have the idea that no one else is supposed to think of new or good devices and so they appropriate all that are proposed and pass them in as their own.

The old saying that "two heads are better than one" was never more true than in the shop, even though some of the shop systematizers seem to believe that all the brains of the establishment must be in the office. The foreman's main duty is to see that all the work goes through on schedule time, and he usually has few spare moments to devote to working out new ideas. The man actually doing the work often sees a better way.

No shop can hope to get the benefit of its men's ideas if credit for them can be appropriated by someone else. The men soon learn that the manager is led to believe that only one or two men have ideas, and the sources of the suggestions run low, like a spring in dry weather.

One of the most successful shop managers we ever knew was not a good mechanic and never pretended to be. But he was a splendid executive, who inspired confidence in his men and who always went out of his way to give credit to any man who advocated a good idea, even if it could not be used. In this way he secured the loyal coöperation of all his men and the shop gained accordingly.

It takes a broad man to always see that even the lowest subordinate receives credit, but it pays in dollars and cents, as well as in the respect of all concerned.

If the foreman understands that he is not expected to originate all the good ideas of the shops, but that he can do as much good by encouraging the others to think and contribute, he will be much more apt to give due credit in each case.

New Publications

A German edition of "American Foundry Practice" and a French one of "Moulders' Text Book" have recently been published. The former has been translated by Ernst A. Schott and published by Verlag Von Hermann Meusser, Berlin. The latter, translated by Par P. Aubie, is published by Gauthier-Villars, Imprimeur-Libnaire, Paris. This French translation contains only that portion of "Moulders' Text Book" treating of Cupola practice.

The Mechanical Engineers' Pocketbook. By William Kent. Eighth edition, rewritten. 1461 4x6½-inch pages. John Wiley & Sons, New York. Chapman & Hall, Limited, London. Price, $5 net.

Until now the successive editions of Mr. Kent's pocketbook have been revised by inserting new paragraphs in place of old ones, and by adding lettered pages and an appendix; but the wear of the electrotyped plates and the advances in engineering practice have brought about the necessity for resetting the type and rewriting much of the book. Under the circumstances, a thorough revision has been made, and while its users will still recognize in the book the face of an old friend, they will also find a large amount of new material, as is shown by the fact that although a large amount of old material has been condensed or omitted altogether, the new volume contains over 350 pages more than its predecessor.

While it remains an engineers' pocketbook, it contains, nevertheless, an increased amount of information of immediate use in the drawing room and shop. One can scarcely open it without finding the results of recent experimental investigations and from such a diversity of sources as to call for unstinted admiration of the industry and painstaking effort of which the book is nothing less than a monument.

The entire engineering profession is under obligations to its author, and we are glad to know that the obligations are being discharged by a liberal and adequate patronage.

We are glad to note that special attention has been paid to the most important part of a book of this character, the index. There is no test of an index but use; but the fact that the present index covers 45 pages—more than twice its former length—shows plainly enough that the author is alive to the importance of this feature.

Personals*

Charles W. Nash has been appointed general manager of the Buick Motor Car Company, Flint, Mich.

Charles L. Allen, of the Norton Company, sailed on Oct. 5, to make a business trip in Europe.

William H. Yetma, formerly with the firm of J. J. McCabe, is now representing the McCabe Machine Company, New York City.

Brown Jackson is requested to communicate with Ed. Montague, superintendent, Holms Machine Manufacturing Company, Sparta, Mich.

Joseph W. Bramwell has been elected vice-president and secretary of the Screw Cutting Company of America, Philadelphia, Penn., succeeding E. W. Crellin as secretary.

William C. Cuntz has been elected vice-president and general manager of the Goldschmidt Thermit Company, New York City, succeeding E. Stutz, who retires from the direction of the company.

Harold L. Pope, until recently chief engineer of the Matheson Motor Car Company, Wilkes Barre, Penn., has become manager of the Pope Manufacturing Company, West Works, Hartford, Conn.

F. Gold, for a number of years connected with the Pittsburg Meter Works, of East Pittsburg, Penn., has resigned to accept a position as superintendent with the Hays Manufacturing Company, Erie, Penn.

M. Lapham, for a number of years connected with the Lackawanna Steel Company in an executive capacity, severs his connection with that company to become associated with B. F. Goodrich Company, Akron, Ohio.

Henry W. Hoch has become superintendent of the Pennsylvania works of the National Tube Company, Pittsburg, Penn. Mr. Hoch was formerly superintendent of the pipe department of the Youngstown Sheet and Tube Company, E. Youngstown, Ohio.

*Items for this column are solicited.

New Tools and Shop Appliances

High-Power Vertical Surface Grinder

The illustrations show the high-power vertical surface grinder built by the Blanchard Machine Company, Cambridge, Mass.

Fig. 1 is a general view of the machine which is shown with the water guard removed. The work is carried on a 24-inch rotary magnetic chuck supported on a sliding table which may be quickly moved clear of the wheel to place and remove work and returned under the wheel against a stop. The rotating chuck runs on a ball bearing of large diameter submerged in an oil bath, and is securely gibbed down by a ball thrust bearing at the center, so that overhanging work can be ground without danger of tilting the table. The drive is by splined shaft and bevel and spur gears of wide face, running in oil baths. The reduction from spline shaft to chuck is 9:1.

The Wheel

The ring or cylinder wheel is 16 inches in diameter and is cemented into a special retaining ring which is attached to the faceplate by six screws. The wheel and ring are a unit during the life of the wheel, six rings being sent with each machine so that six wheels can be kept mounted and ready for use.

The Spindle

The spindle, which is shown in Fig. 2, is a steel forging of large diameter which is further stiffened by the cast-iron drum for the driving belt. The faceplate is keyed to the lower end on a taper, and secured by a nut threaded onto the spindle.

A Hess-Bright ball-thrust bearing of generous size, mounted directly on the faceplate, takes the upward thrust due to the pressure of the wheel against the work.

The main spindle bearing, directly above this thrust bearing is taper, of large diameter, and adjustable for wear by turning a threaded collar which is self-locking in any position. The phosphor-bronze bushing which forms this bearing is surrounded by an oil pocket containing nearly a quart of oil which is rapidly circulated through the bearing as long as the spindle is in motion. A gage indicates the oil level and permits of easy replenishing. The thrust bearing is provided with independent lubrication, in addition to that from the main bearing, by a compression grease cup on the front of the head.

The upper end of the spindle has a radial ball bearing for side load and a ball thrust bearing for vertical load. The weight of the spindle and revolving parts is transmitted to this thrust bearing through eight springs which are adjusted to press up against the cap on the upper end of the spindle with a force somewhat greater than the weight of the revolving parts. This keeps everything up tight against the lower or main thrust bearing and eliminates all possibility of end shake. Expansion effects are imperceptible owing to the short distance from this lower bearing to the wheel face. The only running joints in the upper box are the ball bearings, which are in an oil bath provided with a gage for indicating the level. Both upper and lower bearings are dust tight and oil retaining and will run for days without attention.

The Head

The lower spindle-bearing housing is of one piece with the main casting of the sliding head. The upper bearing box

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

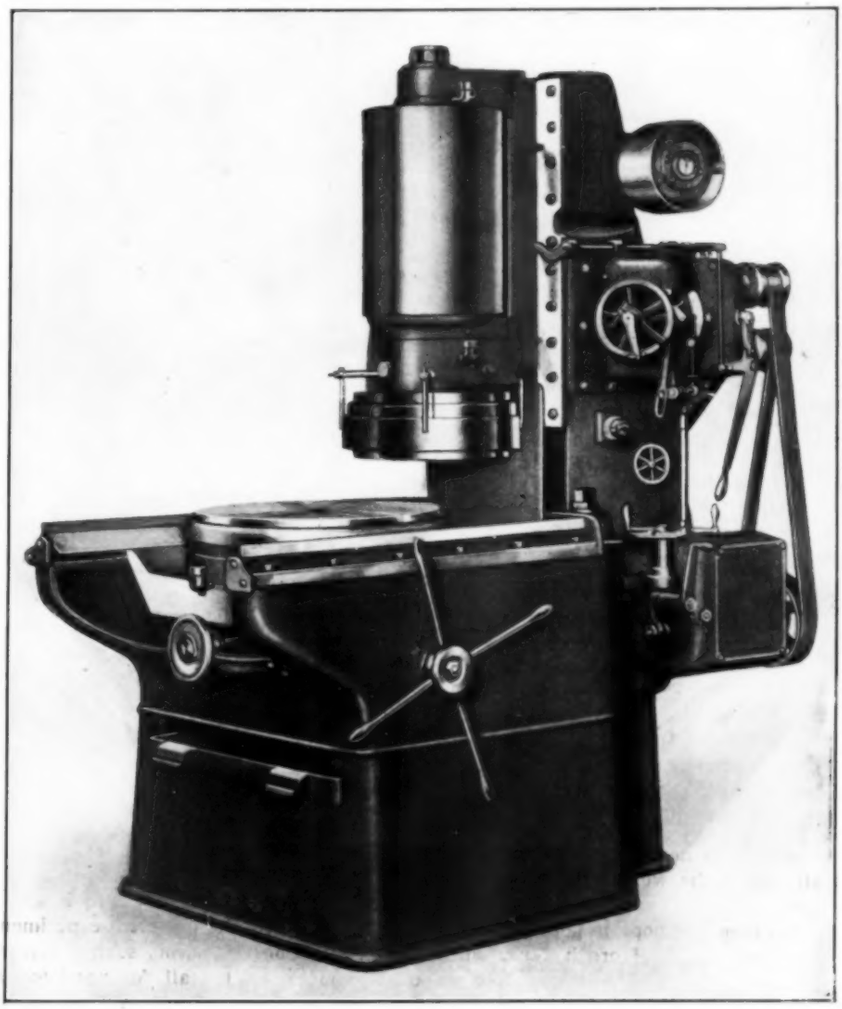


FIG. 1. HIGH-POWER VERTICAL SURFACE GRINDER WITH WATER GUARD REMOVED

fits a bored seat in this casting and is firmly bolted to it. These bolts are easily accessible and by removing them, and the faceplate, the upper bearing with the drum and spindle may be removed.

The head is secured to the column by a square slide of massive design. The sliding surfaces are continuous for the entire length of the head, are grooved for distributing the oil, for which oilers

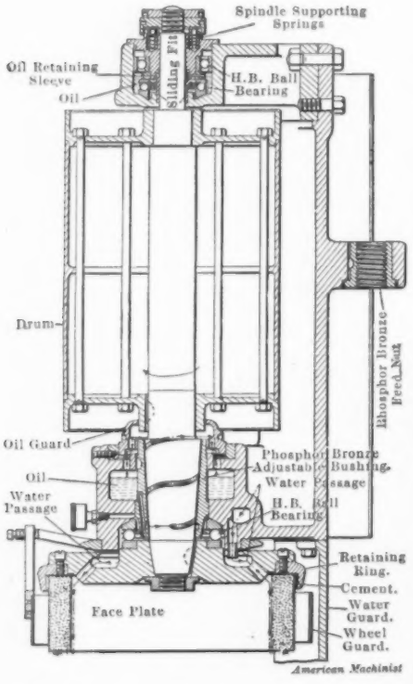


FIG. 2. SECTION OF HEAD AND WHEEL

are provided in a convenient location, and are thoroughly protected from water and grit by a continuous iron guard behind the wheel which is bolted to the under side of the head.

HIGH-POWER DRIVE

The massive construction of the head and wheel spindle renders it practicable to place the driving pulley directly on the spindle. A 5-inch double belt is led from the countershaft down to an idler pulley on the front of the column whence the belt passes forward to the drum on the wheel spindle, returning over a similar idler on the rear of the column to the countershaft. The idler pulleys are of the Blanchard self-oiling type.

The countershaft has ring-oiling bearings of ample size. At a spindle speed of 1000 revolutions per minute the wheel speed is 4190 feet per minute, and the belt speed 3670 feet per minute. The 5-inch double belts should transmit over 25 horsepower at this speed without excessive tension. If more power should be needed for large work the belt may be tightened without danger of heating in any bearing.

A 2-inch double belt from the countershaft drives the pump pulley and from a step on this pulley another 2-inch double belt is run over the raising and lowering clutch pulleys to the table-gear box pulley.

Two belts from the counter and one small belt on the machine are all that are used in this drive; all table speeds are geared and the wheel spindle has but one speed.

THE COLUMN

The column is of box section with heavy inside webs, and with the long and heavy head a rigid support for the wheel spindle is secured.

The column is supported on the bed at three points, and bushings threaded into the column and bearing on the bed allow vertical adjustment at these three points. Large holding-down bolts pass through the bushings and thread into the bed. The construction of the bushings and washers

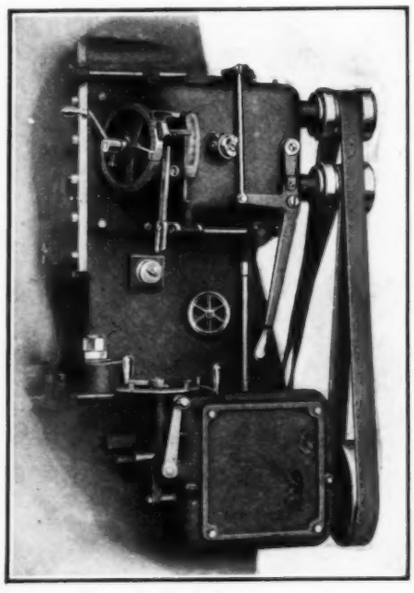


FIG. 3. GEAR BOXES AND FEEDS

is such that adjustment is easily made at any time. At the same time rigid connection is secured, since all backlash in the bushing threads is taken up by the clamping effect of the central belt. The rear washer is graduated for convenience in setting the column forward should it be desired to concave saws or similar work.

THE FEED

The sliding head is let down, not pulled down, upon the work. A heavy lead screw located in a recess between the head and the column runs in a phosphor-bronze nut fixed in the head. Its lower end is supported by a ball bearing of generous size set into a recess bored in the front of the column casting. Steel bevel gears with planed teeth connect with the feed-box shaft. A ratchet device, Fig. 3, feeding once per revolution of the table, constitutes the automatic feed. A shield is provided which may be set to stop this feed at any desired point.

POWER ELEVATING AND LOWERING MECHANISM

Two friction-clutch pulleys running in opposite directions connect with the feed shaft, and a single lever convenient to the operator controls these clutches, enabling him to run the head rapidly to any position. Overtravel in either direction is prevented by a simple device which positively returns the operating lever to the neutral position when either limit of travel is reached by the head.

TABLE SPEED BOX

The splined shaft operating the table is driven from a constant-speed pulley at the right of the machine through a gear box, Fig. 4, giving eight speeds. A sliding key of ample size serves to connect any one of four gears to the second shaft of this box, while a similar key in the first shaft has two positions, direct drive and back-geared drive. A simple friction band, easily accessible for adjustment, serves to relieve any shock due to the sudden engagement of the key and permits the use of a plain jaw clutch for starting and stopping the table. Levers for speed changing and starting and stopping the table are grouped at the left of the box convenient to the operator. All the gears are of wide face, accurately cut, and run in oil. The speed may be instantly changed while running, without disengaging the clutch.

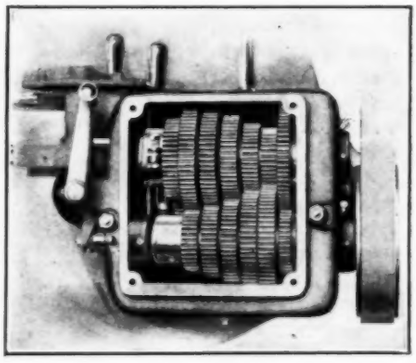


FIG. 4. TABLE GEAR BOX

WATER SUPPLY

A submerged centrifugal pump of large diameter is provided, supplying water through pipe and hose to a cored passage behind the lower spindle bearing in the head, whence it passes down through short tubes into an annular recess in the faceplate and thence outward and downward to the inner face of the wheel. Except for vertical stiffening webs the bed is open down to the bottom, the

lower section being the water tank. Suitable guards prevent any escape of flying water or spray.

A valve with special seat to prevent damage from grit controls the supply of water to the wheel and is moved by a handwheel convenient to the operator.

All important bearings and all continuously running gears, except the pump gears, have oil-bath lubrication and need attention only occasionally, as indicated by the gages.

The machine swings inside of regular guards, work up to 30 inches diameter, and the maximum hight under a new wheel is 12 inches. The chuck speeds range from 3.5 to 30 revolutions per minute. The lower bearing of the spindle is 3 to 3¼ inches diameter by 6½ inches long. The spindle drum is 14 inches in diameter. The machine weighs 6800 pounds.

A Continuous Milling Machine

The halftones show a milling machine designed to load and unload without stopping and to be continuous in its operation. This continuous operation is obtained by strapping a number of pieces of the work in a suitable fixture to a rotary table, the feed being continuously in one direction, passing the cutters in a circular path, each piece being removed after it has been milled and its place taken by a rough casting or forging as the case may be. The machine is not designed for circular work as might be inferred, though such work can be handled conveniently, but for the single purpose of machining those pieces that can be milled with face, side or straddle mills, and includes such work as links, levers, connecting rods, universal joints, forks, clutch yokes, brake-rod connections, gear-shifting fingers, and other automobile parts, flat irons, seats of small brackets, flanged members such as the smaller sizes pipe fittings, valves, manifolds, hand-hole covers, valve covers, connecting-rod brasses, and such gun and revolver parts as frames, triggers, hammers, breech-blocks, magazines, receivers, etc.; in fact any small part on which there are plain surfaces to be machined or bosses to be faced.

The spindle is of crucible steel with conical bearings running in bronze boxes permitting adjustment in case of wear. It has a No. 11 taper hole for the reception of the shank of the arbor or end mills. The nose, which is slotted on the end for positive driving of the arbor, is 3 inches diameter and threaded for the larger sizes of face mills. A ¾-inch hole runs through the spindle and a draw-bar is provided for holding the arbor and cutters in the taper hole.

The drive is of the direct-gear type from a tight and loose pulley which runs at a constant speed and may be belted direct to the line shaft or to a jack shaft as desired. Transposing gears are provided for the various changes of speed, twelve of which are included, giving six changes in geometrical progression ranging from 20 to 200 revolutions per minute.

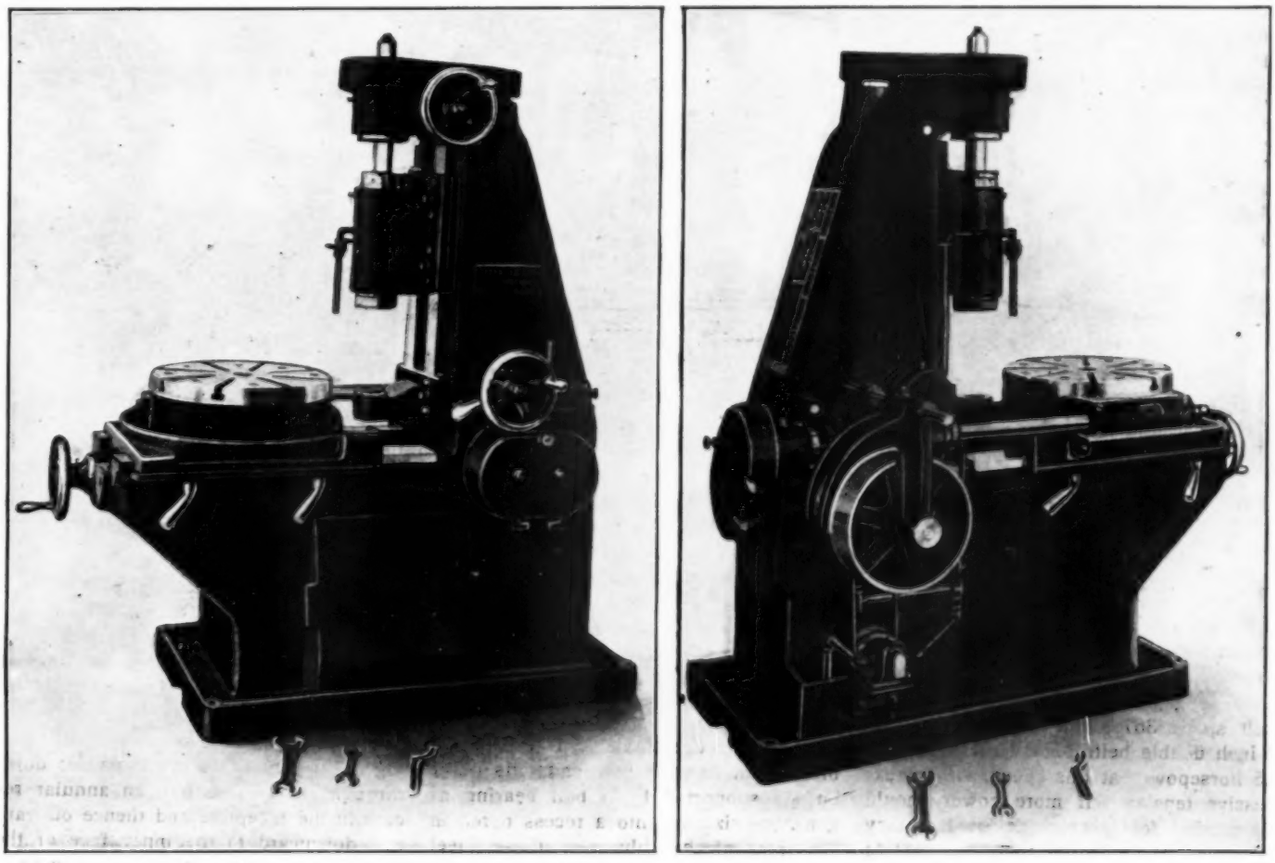
The table is rotated through gearing, the changes of feed being obtained by transposing gears; six changes in geometrical progression being obtained by the twelve gears provided, ranging from 1⅝ to 5½ inches per minute at the periphery of the table.

The table, which is 18 inches in diameter, is centered in a large conical bearing and rests on a wide flat bearing flange which is flooded with oil, giving a support close to the outer edge.

The worm wheel, which is fastened to the table and rotates it, is 16 inches in diameter and is driven by a worm of coarse pitch which also runs in oil.

Setting of the work and cutters is accomplished through the use of the graduated micrometer dials in connection with the handwheels. These dials read in thousandths of an inch.

The table may be rotated by handwheel or power, the latter being controlled by



FRONT AND REAR VIEWS OF THE CONTINUOUS MILLING MACHINE

clutch and lever. The handwheel and lever are located in a convenient position on the front of the machine.

A hardened steel bushing in the center of the table provides means for accurately locating the fixtures in the center of the table and the eight slots provide ample provisions for clamping the fixture to the table.

A removable chip pan is placed directly under the cut and all oil and chips are conveyed to this point. The oil tank is cast integral with the bed and a pump and fittings are regularly furnished.

The bed is of box section and extends to the floor; it is provided at the bottom with a rim to protect the floor from over flow of oil.

The fixtures required are of simple construction owing to the character of the work machined.

The machine occupies floor space of 44x68 inches and weighs, net about 3300 pounds.

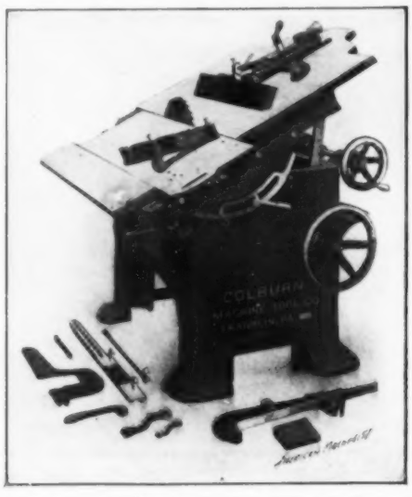
It is manufactured by the Barber-Colman Company, Rockford, Ill.

The Colburn Universal Saw Table

The halftone shows a universal saw table for patternmakers, etc., built by the Colburn Machine Tool Company, Franklin, Penn.

The main frame of the machine is in one piece. The table is 42 inches long by 40 inches wide. The entire table can be tilted to any angle up to 45 degrees. The ripping gage may be set to rip stock up to 21 inches wide.

The regular equipment furnished con-



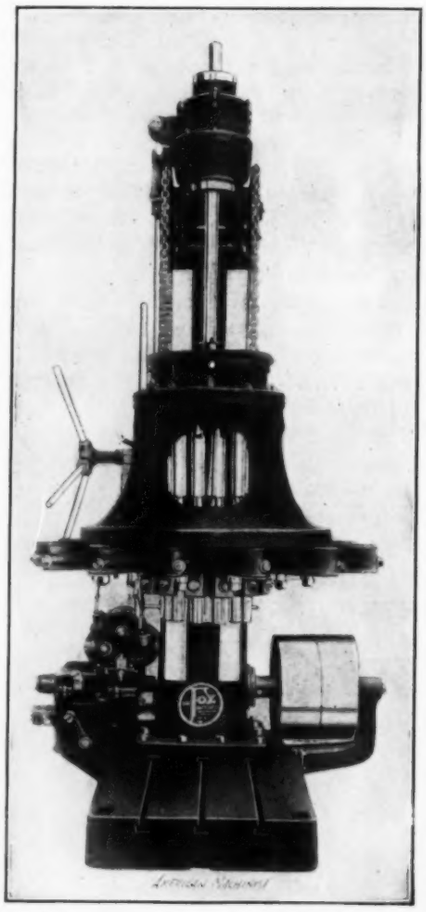
COLBURN UNIVERSAL SAW TABLE

sists of countershaft; two 14-inch saws, one splitting fence; one cutting-off gage; one auxiliary cutting-off gage for cutting stock to exact length from 1 inch to 50 inches; one extension cutting-off gage for finished moldings and similar work, so as to cut with the grain of the wood; one cut-off gage block for cutting off short pieces; complete set of wrenches, taper pins, thumb-screws, etc.

The machine weighs 1700 pounds and occupies floor space 42 by 42 inches.

A Multiple Spindle Drilling Machine

The halftone shows a new machine which has just been placed on the market by the Fox Machine Company, of Grand Rapids, Mich. This machine is known as



A MULTIPLE SPINDLE DRILL PRESS

their No. 5 Drill, and is intended for the drilling of gas-engine frames, cylinder parts, automobile transmissions, pump flanges and work of similar character. The machine is designed for either belt or motor drive. When belt drive is furnished a single constant-speed pulley is of large diameter and broad face. All changes of speeds and feeds are obtained through gear boxes, and transmission is of the selective sliding gear type. All driving gears run in oil baths, and all main bearings are self-oiling and are of special bronze metal. The principal gears of machines are 3½ per cent. nickel steel. The machines carry drills up to 1½ inches in diameter, eight drills of this size can be used at one time.

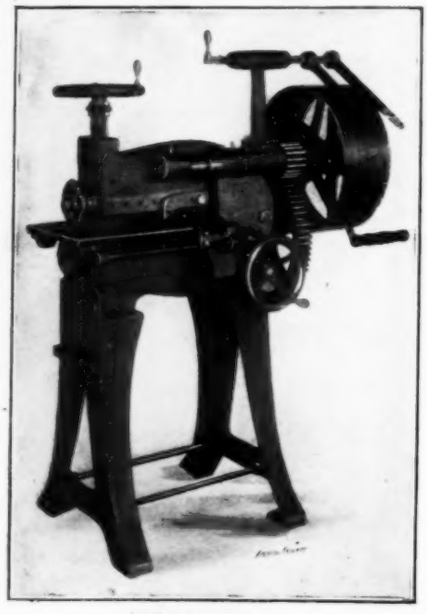
A friction tapping device, located on top of column can be furnished with these machines. The clutches are of the expanding-ring type, provision being made for adjustment of clutches as is necessary. All levers are within easy reach of the operator, provision is made so that the drills may be stopped without shifting the belt on the machine. These machines are built to drill at any rectangular layout up to 16x30 inches or any circular layout up to 24 inches in diameter.

There are six changes of spindle speeds varying from 200 to 675 revolutions per minute, and six changes of head feeds, which vary from 0.787 to 6.92 inches per minute. A single lever is used for engaging and disengaging feed mechanism, and an adjustable stop for automatically releasing the feed.

Niagara Rotary Shears

The principal feature of the rotary slitting shear shown herewith is the slitting gage with parallel motion. It is necessary to move the gage toward or away from the cutters according to the width of the strips to be cut. To enable the operator to make this adjustment rapidly and accurately, both ends of the slitting gage are moved in unison. This is accomplished by having a screw pass through a lug on each end of the slitting gage. The screws are revolved by turning the handwheel.

Rollers are mounted in the face of the slitting gage to reduce the friction between the edge of the material and the gage.



A ROTARY SHEAR

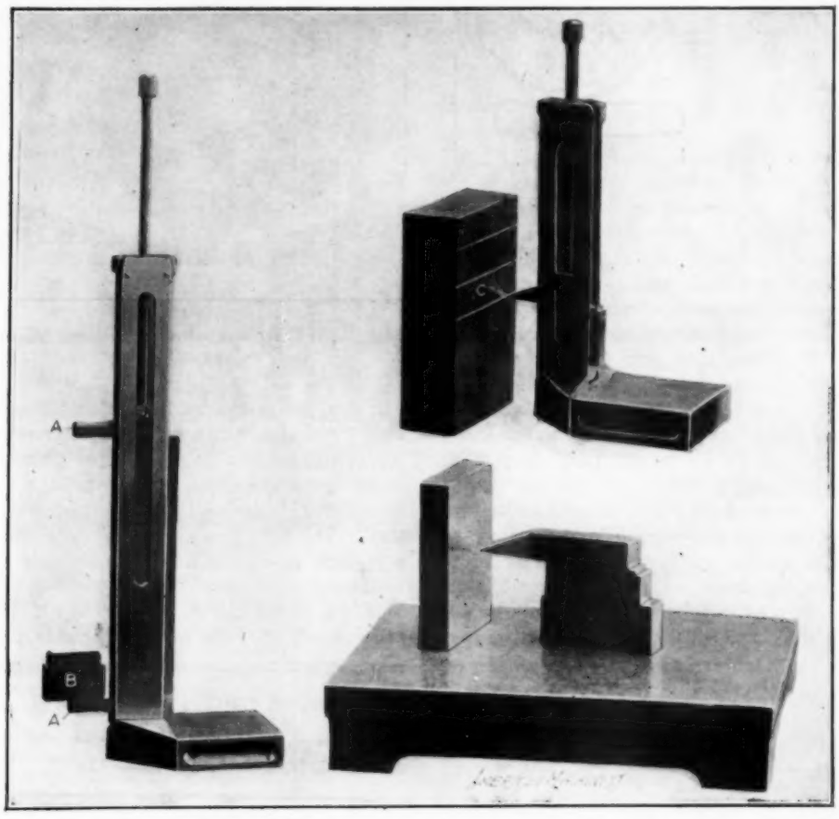
Another feature of the shears illustrated is the holddown attachment that bears upon the stock while it passes through the machine.

Attachments of this character can be applied to any of the rotary slitting shears turned out by the Niagara Machine and Tool Works, Buffalo, New York.

New Applications of the Johannson Gages

The halftones show new fields of usefulness for the Johannson gages which are handled in this country by the Grönkvist Drill Chuck Company, 18 Morris street, Jersey City, N. J.

Fig. 1 shows a base with vertical member similar to a surface gage. The vertical member is provided with a clamping screw for holding the gages in place. This device is used as a measuring machine for such work as testing measuring rods. The two pieces *A* are built out on the regular gages to a distance greater than the longest gage to be tested, then by building up separate gages *B* and laying them on the lower piece *A* the length of the gage can be accurately measured.



FIGS. 1, 2 AND 3. A MEASURING MACHINE AND HIGHT GAGE

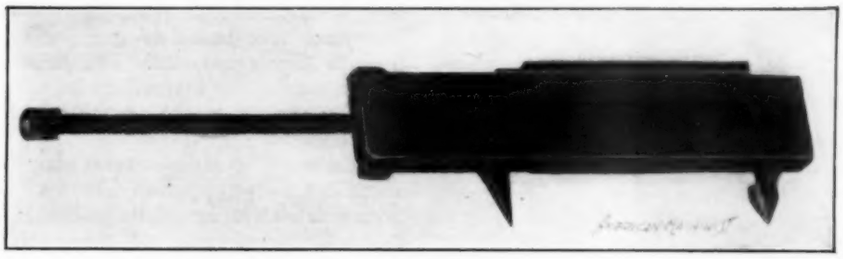


FIG. 4. A PRECISION TRAMMEL

Fig. 2 shows another application of the base shown in Fig. 1. The scribing point *C*, Fig. 2, is made with the same care and accuracy as the gages in the Johannson set. Its lower face, as shown in the halftone, is a true plane, while one end is shaped at an acute angle, as shown. The distance from the bottom of the base to the seat, in the upright, for the Johannson gages, is a known quantity, which can easily be checked by the gages from time to time. Distances greater than this, from the bottom of the base to the bottom of the scribing point can be readily obtained by wringing together the correct gages and the scribing block and then securing them in the vertical member by means of the clamping screw. This combination makes an efficient and extremely accurate hight gage.

Fig. 3 shows another application of the hight gage for scribing measurements less than the smallest possible with the base shown in Figs. 1 and 2. In this case the scribing block is wrung on the required blocks and used without any base.

Fig. 4 shows a holder with a stack of blocks. On one end of the stack is a block having at one end a conical point. This conical point is exactly in line with the plane surface next the stack of blocks. The scribing point is wrung on the other end of the stack and the whole is secured in the holder. With this arrangement accurate distances or circles may be scribed from a prick-punch mark as a center.

Motor Mount for a Garvin Universal Milling Machine

Fig. 1 shows a motor mount applied to the standard No. 1½ universal milling machine. The controlling feature of the design was to have a mount which could be attached to a machine in stock, thus avoiding the expense and delay in covering the motor-drive requirements. The motor can be mounted as shown, or on a bracket at the rear of the machine—preferably the latter, as it makes the entire outfit portable. The impression that the power of the machine is deficient on account of the short center distance between cone pulleys, is erroneous. The detail of this drive is shown in Fig. 2. The high-speed narrow belt drives on to a two-speed cone, which back gears to the main cone through a double back-geared system as shown, giving eight changes each of speed by belt or gears, totaling 16 changes of speed. Both overhead cone pulleys run on a stationary shaft stud, that is made hollow to allow of supplying the lubricant from grease cups at both ends. This shaft is keyed to the eccentrics, one of which has

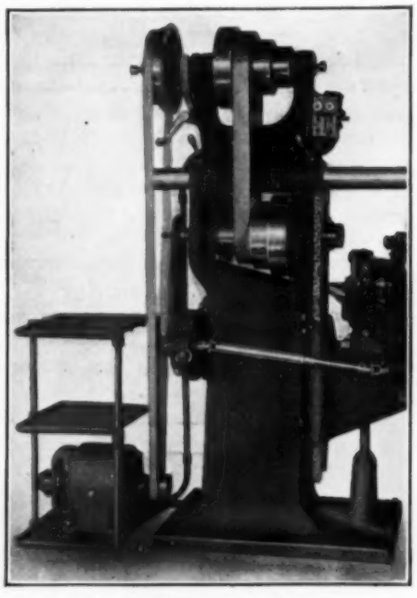
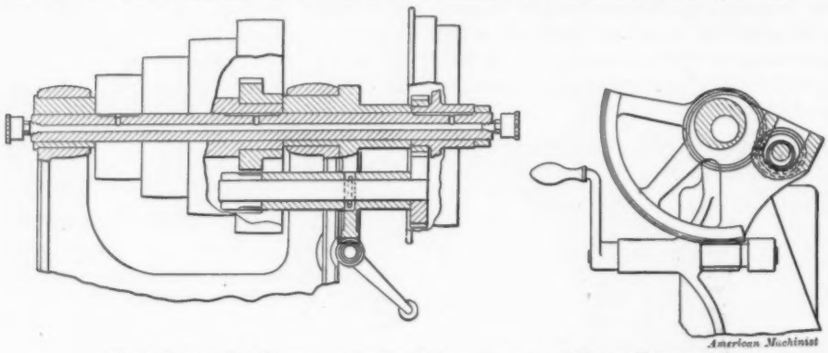


FIG. 1. MOTOR MOUNT FOR GARVIN UNIVERSAL MILLER

a segment worm gear under control of a crank, as shown in Fig. 3. This scheme is used to give the proper tension to the belt, allowing it to be quickly eased off for shifting purposes. No lock is necessary to retain the belt tension. The ease with which the belt is tightened is conducive to high production. The feed from the spindle to the rotary feed-change box is by chain. Other points of the machine have been clearly set forth in a previous issue.

The machine is manufactured by the Garvin Machine Company, Spring and Varick streets, New York City.



FIGS 2 AND 3. DETAIL OF THE DRIVE AND THE BELT TIGHTENER

A Universal Grinder

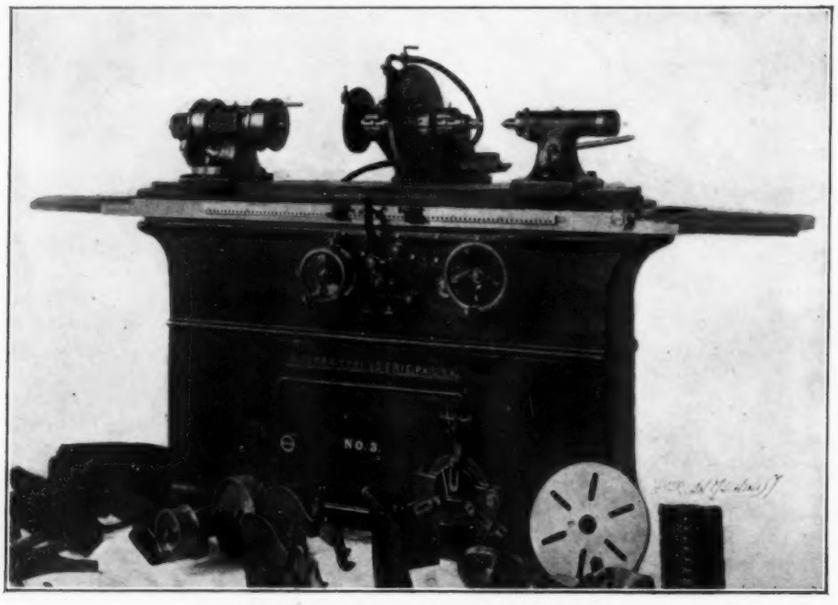
The halftone shows a No. 3 Modern universal grinder built by the Modern Tool Company, Erie, Penn.

In the design of this grinder especial attention has been given to rigidity. As will be seen by the illustration the main frame of the No. 3 modern universal grinder is nearly as long as the ways themselves which have practically no overhang, and are, therefore, evenly supported throughout their entire length, preventing any possible errors in alinement. The headstock and footstock and wheel mountings are also exceptionally heavy. In every part of the grinder itself, and also the fixtures and attachments, rigidity is the salient feature.

Smooth running of the sliding table is assured by simplified worm gearing, correctly mounted, ample power and large bearing surfaces which insure long life of the entire driving mechanism.

To those who are familiar with the good points of a universal grinder attention is called to the method of clamping the headstock and footstock to the swivel table as shown in the cut. In this arrangement a very large positive edge is obtained which is located out of the way of grit and water. By loosening the gibs on the head- and footstocks for relocating them on the swivel table any wear on the positive edge or gibs is prevented, and this edge will remain perfectly straight throughout the entire life of the grinder without rescraping.

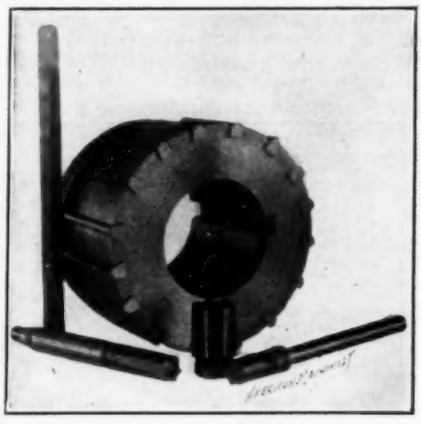
The reversing mechanism is mounted on a bracket bolted to the outside of the machine where it is easily accessible for oiling, and can be quickly removed for cleaning or repairs by taking out four screws.



A NEW UNIVERSAL GRINDING MACHINE

A Large Adjustable Reamer

The adjustable reamer shown in the accompanying halftone is 10 inches in diameter, weighs 92 pounds, and is probably one of the largest reamers ever made.



AN EXCEPTIONALLY LARGE ADJUSTABLE REAMER

It was made by the Lapointe Machine Tool Company, Hudson, Mass., for reaming cylinders, and on account of its size is of special interest. It is made with high-speed blades and body of machinery steel. The body has a 4½-inch hole with a ¾-inch keyway in it for convenience in fastening to arbor.

In the rough the steel from which the body was made weighed 152 pounds.

Specimens and Information of Iron Castings Wanted for Research Purposes

Knowledge of the true cause of globules in gas cavities, solidly incased shot iron, hard streaks or spots in castings and white iron inside of gray or soft iron, is greatly required. The theories and suppositions of the past do not satisfactorily explain causes or tender positive remedies.

A collection of samples containing the above defects accompanied with the following details of conditions to enable a thorough investigation of the subject which should prove of much value in assisting to obtain more accurate information than exists are solicited by Thomas D. West, 10,511 Pasadena avenue, Cleveland, O. Samples of the defects and information requested as below will be gladly received from foreign countries as well as the United States up to the end of this year. In forwarding any specimens, information is desired upon the following points as far as practical:

First. Character of the pig and scrap, fuel and any flux used in melting the mixture; also state if anything unusual occurred or was observed during the

heat. Grade of the iron produced in being soft, medium or hard, or better still, an analysis of the casting.

Second. A rough sketch of the casting showing its form and thickness of the different sections as far as feasible, along with marking the location of the sample forwarded.

Third. Whether the mold was green sand, skin dried, dried sand or loam and a description of gating and pouring.

Fourth. Whether the metal at the time of being tapped as well as being poured into the mold was "hot," medium or "dull," and any other information as far as convenient that might be thought of value in assisting an intelligent modern research of the subject.

The results of this investigation will be given to the trade and general public through the medium of a paper to some one of our foundry or engineering societies.

The Real Costs of Using the Wrong Tools

There are a good many little points that we are very apt to overlook in figuring shop costs unless we have had the sad experience of having an apparent profit and a call from the bank for more funds at the same time.

Take the matter of grinding wheels. We are very apt to feel that it is foolish to stop work and change for a little softer wheel on a certain job. The wheel we have is almost right and we push along, little realizing that we are wasting several valuable hours to save changing a wheel.

Or, it is just possible that we have not one of the wheels we need.

In either case the workman's time keeps right on, like the gas meter, and the machine keeps on running, using power and wearing itself out.

Some are foolish enough to use a hard wheel for most work because it does not wear out so fast. But the cost of the wear on a wheel is a mighty small item as compared with the other costs which go on forever. A record of long life for a grinding wheel may be a record of the worst kind of wastefulness, if the wear of the wheel is the only thing that is considered.

Then there is the running of a machine which you know runs hard. A little attention to the bearings and proper lubrication would take less power and be better in every way. And we are too apt to forget that when a machine takes a lot of power to run it, there is more than the cost of the power to be considered. The excess of power means excess of wear to the machine, which makes itself felt in cost of repairs and time lost while out of commission.

Dull milling cutters and tools of all kinds come under the same head.

Increasing Shop Capacities

Metal Working

NEW ENGLAND

The Revere Rubber Company, Boston, Mass., will erect a plant at Providence, R. I., including machine shop.

The Boston State Hospital, Dorchester Center, Mass., will need equipment for new machine shop and carpenter shop.

MIDDLE STATES

Renaud & Son, Carthage, N. Y., are adding a machine shop to their foundry.

The Canadian Tube and Iron Company will locate a large plant at Montreal.

The Buffalo (N. Y.) Gasolene Motor Company will erect a two-story addition.

The Howard Motor Car Company, Galion, Ohio, will build several new buildings.

The Bayonne (N. J.) Casting Company will build a $30,000 addition to its plant.

The Michigan Central will equip a large new round house and shops at St. Thomas, Ont.

The De Laval Steam Turbine Company, Trenton, N. J., is erecting an addition to its plant.

The Detroit (Mich.) Injector and Brass Manufacturing Company will erect a new factory.

The Light Manufacturing Company, Pottstown, Penn., has prepared plans for a new foundry.

The Toledo (Ohio) Stove and Range Company is looking for site on which to erect a plant.

The Lake Winnipeg Shipping and Supply Company will locate a ship-building plant at Winnipeg.

The Auto Motor Castings Company, Chagrin Falls, Ohio, is looking for a suitable site for its plant.

Bramley Brothers, North Tonawanda, N. Y., are considering plans for the erection of a new iron foundry.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

The plant of the Percival Plow and Stove Company, at Merrickville, Ont., destroyed by fire, will be rebuilt.

The Abendroth & Root Manufacturing Company, Newburgh, N. Y., is improving its machine-shop equipment.

Fire did $15,000 damage at the plant of the Marine Manufacturing and Supply Company, New Brunswick, N. J.

Fire destroyed the factory of the Atlas Metal Bedstead Company on West Twenty-fifth street, New York.

The Thew Automatic Shovel Company, Lorain, Ohio, is contemplating the erection of a $125,000 addition.

Bartlett, Hayward & Co., Baltimore, Md., has had plans prepared for a two-story addition to its machine shop.

Contract has been awarded for the erection of a new plant for the McCaskey Register Company, at Alliance, Ohio.

The Newburgh (N. Y.) Chamber of Commerce is looking for site for an automobile factory for a French concern.

Plans are being prepared for a two-story garage and factory for the Loraine Motor Company, Philadelphia, Penn.

It is reported the McShane Bell Foundry Company, Baltimore, Md., is contemplating additions to its brass foundry.

The Steely Auto Engine Company, of Detroit, Mich., it is said, has plans under way for erecting a new plant in the Central West.

The Lake Superior Iron and Chemical Company is making improvements at its plant in Manistique, Mich., including new machine shop.

The New York Central Railroad is building a new repair shop at Jersey Shore, Penn., which is to be equipped with modern machinery.

Wurtz & Son, Buffalo, N. Y., has acquired a new plant and will increase their output. The company manufactures structural iron and steel.

The Vulcan Furnace Company, Detroit, Mich., will move its plant to Warren, Ohio. Sixty thousand dollars will be expended on new shops.

The roundhouse and shops of the New Brunswick Coal and Railway Company, at Minto, N. B., destroyed by fire, will be replaced at once.

The Wilson Motor Car Company, Newark, N. J., has been incorporated with $50,000 capital by Samuel F. Wilson, John Foley, Jr., and Gustave A. Lutz.

The Casey Aluminum Foundry Company, Chicago, Ill., has been incorporated. Capital, $20,000. Incorporators, E. F. Casey, J. Sandeoritz, Chas. Weinfeld.

It is reported the Falk Company, Milwaukee, Wis., is contemplating the purchase of some tools, including boring mill, lathe, shapers, automatic screw machines.

The Commercial Electric Motor Manufacturing Company, Chicago, Ill., has been incorporated. Capital, $10,000. Incorporators, Chas. Endorf, Jr., C. V. Mount, F. S. Schooler.

The Acme Auto Appliance Company, of Joliet, Ill., has been incorporated by M. F. Lennon, J. H. Garnsey and H. E. Wood, to manufacture and sell automobiles, supplies and accessories.

The J. F. Wiessner & Son Brewing Company, Baltimore, Md., has had plans prepared for a garage to be equipped with the necessary equipment for the repair of its automobile delivery trucks.

The Elgin Wheel and Engine Company, Elgin, Ill., has been incorporated to manufacture machinery and engines. Capital, $30,000. Incorporators, H. L. Thompson, N. W. Johnson, C. F. Terhune.

The Portable Safety Gate Company, Cincinnati, Ohio, has been incorporated to manufacture safety devices for railroads. Capital, $25,000. Incorporators, S. E. Conners, J. H. McMakin, C. W. De Armond, etc.

The Mollenberg-Betz Machine Company, Buffalo, N. Y., has been incorporated to do all kinds of general machine work and repairs. Capital, $10,000. Incorporators, Jacob Betz, Henry J. Mollenberg, etc.

The Fremont (Ohio) Stove Company has been incorporated with $35,000 to manufacture stoves and operate foundry and machine shop. Incorporators, R. J. Christy, Edw. H. Zurhorst, Thos. H. Conway, etc.

The Auto Acetylene Light Company, Cleveland, Ohio, has been incorporated to manufacture illuminating gas lamps and tanks. Capital, $10,000. Incorporators, N. B. Gordon, A. E. Knuth, F. M. Heidl, etc.

The Electro Lighting Company, Indianapolis, Ind., has been incorporated to manufacture and sell electrical machinery. Capital, $100,000. Incorporators, C. C. Wedding, S. C. Renick, Wm. H. Harbison.

The Dayton Bronze Bearing Company, Dayton, Ohio, has been incorporated to manufacture bronze bearings and metal castings. Capital, $20,000. Incorporators, Wm. B. Israel, J. M. Haas, Louis Elbers, etc.

The Haile-Saxton Motor Company, Buffalo, N. Y., has been incorporated to manufacture motor vehicles, automobiles, aëroplanes, etc. Capital, $10,000. Incorporators, Arthur W. Haile, 54 Fifteenth street; Frank J. Saxton, E. B. Smith, 351 Main street, Buffalo.

The Lewis-Weller Manufacturing Company, Utica, N. Y., has been incorporated to manufacture springs, wire mattresses, beds, etc. Capital, $10,000. Incorporators, Wm. Lewis, 86 Lansing street; E. J. Weller, 245 South street; F. Gilmore, 188 Blandine street, Utica.

The Barker-Cardy Machine Company, Jacksonville, Fla., has been incorporated with $15,000 capital by J. R. Barker, Geo. C. Cardy and S. S. Goldsberry. The company will engage in the building and operation of machine shops, boiler works and dry docks.

The Navy Department, Washington, D. C., will open bids October 18, for 15 electric hand drills as per Schedule 2958, on October 25, for one motor-driven geared lathe, Schedule 2952, one high-speed friction saw, Schedule 2969, and on November 8, for one spiral disk grinder, Schedule 2953.

Plans have been completed by the Westinghouse Electric and Manufacturing Company for the erection of a large new plant at Trafford City, Penn. This will include two foundries, one for large and one for small castings, also pattern shop, etc. About $3,000,000 will be expended.

The Smith & Cox Company, Bayonne, N. J., has been incorporated to manufacture pipe and tube bends and coils. Plant is now being erected at Fifty-seventh street and avenue A, for which equipment is needed, including pipe-threading and cutting machines, electric-welding machinery, oxide-welding apparatus, bending machinery, lathes, drills, shapers, etc.

SOUTHERN STATES

The Hartselle (Ala.) Machine Company will construct machine shop and foundry on West Main street.

The Champion Wire and Iron Works, Louisville, Ky., has purchased site on which a new plant will be erected.

The Howe Company, 1019-21 Buxter avenue, Louisville, Ky., manufacturing brass goods, is looking for suitable site for a new plant.

The Cadillac Motor Car Company, Detroit, Mich., is negotiating with the Board of Trade, of Nashville, Tenn., with a view of locating a branch factory there.

WEST OF THE MISSISSIPPI

O. M. Cobb, Elwood street, Los Angeles, Cal., will erect a blacksmith shop.

The Neosho (Mo.) Foundry and Plow Works is considering establishment of a plant at Dallas, Tex.

The Earl F. Schack garage, at Escondido, Cal., will be enlarged and equipped with additional equipment for repair work.

The Oklahoma City (Okla.) Foundry and Machine Company is in the market for a portable boring bar and a 16-inch lathe.

The Keller-Thomason Manufacturing Company, of Covinia, Cal., manufacturing irrigation appliances, will move to Los Angeles, where a new plant is being erected.

The Shaw Electric and Machine Company, of Brawley, Cal., will erect a garage in Los Angeles. A complete equipment of automobile repair and vulcanizing machinery will be installed.

The Hydro Patent Power Company, Portland, Ore., has been incorporated to manufacture and sell machinery for generating power by water. Capital, $1,000,000. Incorporators, Norman R. Smith, Frank Becker, C. M. Idleman.

CANADA

W. H. Wortman will build a large new pump factory at Winnipeg.

The Tobin Arms Company will erect a large new factory at Woodstock, Ontario.

The British Empire Bridge Company will locate a $5,000,000 plant at Montreal.

The Canada Metal Company, of Toronto, is building a large addition to its foundry.

The International Tool Steel Company, Ltd., will erect four buildings at Port Hope, Ont.

A. W. Henderson, of Somerset, England, has secured site at Ottawa, Ont., for his patent saw factory.

The Canadian Northern Railway will build car shops for the entire system, employing 5000 men, at Port Mann, B. C.

The Dominion Iron and Steel Company is making very large extensions to its plant at Sydney, including complete new repair and machine shops.

General Manufacturing

NEW ENGLAND

The Mansfield (Mass.) Bleachery will establish a plant.

The Uxbridge (Mass.) Worsted Company will improve its plant.

The Merriam Company, South Acton, Mass., will buy a steam engine.

The Delta Shoe Company, Cambridge, Mass., is building a new factory.

The Nyanza Cotton Mills, Woonsocket, R. I., will install machinery.

The Cumberland Construction Company, Standish, Me., will install a waterwheel.

The Boston State Psychopathic Hospital, Roxbury, Mass., will install boiler and pumps.

The Providence (R. I.) Box and Lumber Company will build a new plant in Arlington, R. I.

The Hollinsworth & Vose Company, Boston, Mass., is in the market for a concrete mixer.

The Converse Rubber Shoe Company, Malden, Mass., is in the market for a Daniels planer.

The Boston Coated Paper Company, Somerville, Mass., will install a boiler for heating purposes.

The Robert D. Mason Company, Pawtucket, R. I., is erecting a large addition to its bleachery.

The Providence Box and Lumber Company, Cranston, R. I., is making additions to its power plant.

The Davenport Brown Company, Somerville, Mass., is in the market for a two-spindle variety molder.

The Brown & Sharpe Manufacturing Company, Providence, R. I., will install a low-pressure steam turbine.

The Waite-Thresher Company, Providence, R. I., manufacturing jewelry, has awarded contract for the erection of a new factory.

The Boston Woven Hose Company, Cambridge, Mass., will erect an addition to be used for the manufacture of canvas belting.

MIDDLE STATES

Westernport, Md., voted $75,000 bonds for waterworks.

Springfield, Ohio, will improve its waterworks system.

A new municipal waterworks system will be built at Utica, Ohio.

The planing mill of E. C. Gleason, Roscoe, Ohio, was destroyed by fire.

Schleisingerville, Wis., will install pumping machinery for municipal service.

The plant of the Zanesville (Ohio) Barrel Company was burned. Loss, $12,000.

The Federal Knitting Mills Company, Cleveland, Ohio, is erecting a new mill.

The U. S. Cartridge Company, of New York, will erect a plant at Perth Amboy, N. J.

The plant of the Raritan Creamery Company, Neshanic, N. J., was destroyed by fire.

The Edible Oils Company, Bayonne, N. J., will erect another building to cost $11,000.

Benjamin Moore & Co., Carteret, N. J., will build an addition to their paint factory.

The Ironwear Hosiery Company, Elmira, N. Y., is considering the enlargement of its plant.

The Milwaukee (Wis.) Grain and Feed Company will erect a new $40,000 drying plant.

The Anderson Porcelain Company, East Liverpool, Ohio, will rebuild its plant recently burned.

The tannery of the A. O. Troestel Company, Milwaukee, Wis., was destroyed by fire. Loss, $250,000.

The Orford Copper Company, Bayonne, N. J., will build an addition to its plant to cost $36,000.

The boiler and engine room of the Peoria (Ill.) Artificial Ice Company were burned. Loss, $15,000.

The chair factory of Haywood Brothers, on South Fifth street, Philadelphia, Penn., was destroyed by fire.

It is reported that McKee Glass Works Company, Jeannette, Penn., is considering removal of its plant.

The plant of the Knerr Board and Paper Company, Dayton, Ohio, was destroyed by fire. Loss, $175,000.

The hardwood flooring plant of William Horner, at Reed City, Mich., was destroyed by fire. Loss, $49,000.

The plant of the Consolidated Agricultural Chemical Company, Newport, Del., was burned. Loss, $12,000.

The plant of the New York Revolving and Portable Elevator Company, in Jersey City, N. J., was destroyed by fire.

The American Enameled Brick and Tile Company, South River, N. J., is erecting a large addition to its plant.

The Warner Chemical Company, Carteret, N. J., will increase the capacity of its power plant. New boiler will be installed.

The Great Eastern Clay Company, South River, N. J., will install a new boiler and make other improvements in its power plant.

The Singleton Silk Manufacturing Company, of Paterson, N. J., is said to be planning the erection of a mill at Southbound, N. C.

The plant of the Lake Champlain Pulp and Paper Company, Plattsburgh, N. Y., was burned. Loss, $100,000. Same will be rebuilt.

Fire destroyed the power house and boiler plant of the Pennsylvania Marble and Granite Company, Avondale, Penn. Will be rebuilt.

Alois Bohl, South River, N. J., manufacturer of embroideries, is building a new power house. New engine and boiler will be installed.

The National Pulp and Paper Company, Harrisburg, Penn., is to erect a new large and modern paper mill in the Middle Atlantic section.

S. A. Cook & Co. are erecting a four-story building on Main street, Medina, N. Y., to be equipped with electrical apparatus and elevators.

The Continental Condensed Milk Company, Mill Hall, Penn., is erecting a plant. Seventy five thousand dollars worth of machinery will be installed.

Safferson & Weisberg, of New York, are erecting a shirtwaist factory in Lyon, N. Y. Will install equipment for an electrical and steam plant.

The McGuire & Cummings Company, Paris, Ill., manufacturing cars, has plans for the erection of a new plant for which it is trying to secure site.

One hundred and sixty thousand lineal feet of square pipe or tubing, 1¼ x1 ¼ x1/16 inches thick, is wanted to be used for cross-piling strips between lumber. Address "X Y Z," Box 62, AMERICAN MACHINIST.

The Gore Aërocraft Construction Company, Brooklyn, N. Y., has been incorporated to manufacture aëroplanes, etc. Capital, $250,000. Incorporators, F. W. Gore, Geo. L. Woolley, A. L. Squire, etc.

Sealed proposals will be received by the commanding officer, Rock Island Arsenal, Rock Island, Ill., until 2 p.m., October 20, for one two-stage belt-driven air compressor. Full information can be had of commanding officer.

Sealed proposals will be received by the commanding officer, Rock Island Arsenal, Rock Island, Ill., until 2 p.m., October 20, for one 50-horsepower, 30-volt, compound-wound, double-connected motor, with pulley, slide rails and starting rheostat, 400 revolutions per minute.

Sealed proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until 3 p.m., November 3, for an electric-elevator equipment for the post office at New York. Plans are also on file at the office of McKim, Mead & White, 160 Fifth avenue, New York.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids October 18, for 11,700 pounds miscellaneous steel (schedule 2956), 16,250 steel bolts and nuts, hardware and tools (schedule 2958); November 1—780 pounds brass and bronze, 9500 pounds sheet and bar copper, 40,000 pounds ingot tin (schedule 2965), pipe fittings, steam gages (schedule 2966), 850 pounds stud steel bolts, 15,850 steel bolts and nuts (schedule 2965), hinges and locks, padlocks, brass wood screws (schedule 2964).

SOUTHERN STATES

The Acme Box Company, Chattanooga, Tenn., will erect a plant.

City of Lockport, La., is having plans prepared for waterworks.

City of Boaz, Ala., will vote on issuance of $20,000 bonds for waterworks.

The plant of the Baton Rouge (La.) Lumber Company was burned. Loss, $10,000.

The plant of the Genesee (La.) Lumber Company was destroyed by fire. Loss, $50,000.

The city of Rome, Ga., will vote on issuing $75,000 bonds for improving and extending waterworks.

The Bradford Wholesale Furniture Company, Nashville, Tenn., whose plant burned some time ago, is preparing to rebuild.

The West Point (Ky.) Gas, Water and Ice Company is being incorporated with $40,000 capital by W. A. Bomgardner, of West Point, and B. W. Griggs, of Louisville. Plant will be erected at West Point.

WEST OF THE MISSISSIPPI

Gettysburg, S. D., is having plans prepared for a waterworks system.

The city of Mulvane, Kas., is disposing of $30,000 bonds for waterworks.

Elma, Wash., is considering plans for the installation of a waterworks system.

Gilbert, Minn., has voted $25,000 bonds for electric-lighting and sewer systems.

The town of Allen, Okla., will vote on issuing $25,000 bonds for waterworks system.

The Fay Fruit Company, of Uplands, Cal., will build an addition to its plant at Ontario, Cal.

A modern creamery will be erected at Riverdale, Cal., by the Riverdale Coöperative Creamery.

The Schmoller & Mueller Piano Company, Omaha, Neb., is planning the erection of a new plant.

The plant of the American Olive Company, Los Angeles, Cal., was destroyed by fire. Loss, $450,000.

The Pacific Lumber Company, Wilmington (Los Angeles), Cal., is building an addition to its planing mill.

The Oklahoma City (Okla.) Water Works will install two 150-kilowatt direct-connecting units, also new boiler.

The Hub City Laundry Company, of Colton, Cal., will build a modern steam-laundry plant in Los Angeles.

The Merchants Ice and Cold Storage Company, Los Angeles, Cal., has just completed an addition to its plant.

The Pomona Fruit Growers' Exchange, Pomona, is making extensive improvements in its plant at Pomona, Cal.

Albert Willows, of Redlands, Cal., will erect a steam-laundry building in Los Angeles. Equipment will be required.

The Consolidated Gas Company, of Long Beach, Cal., will erect a new gas holder of 500,000 cubic feet capacity in the near future.

The Oklahoma City (Okla.) Railway Company will install two more turbine units of 2500 kilowatts capacity each and another boiler.

The Crescent Wharf and Warehouse Company, at San Pedro (Los Angeles), Cal., will make improvements in its plant to the extent of $10,000.

P. B. Olufs, of Fresno, Cal., is building an addition to his warehouse in this city. A ten-ton traveling crane and modern equipment will be installed.

The Escondido Lumber, Hay and Grain Company, of Escondido, Cal., will erect a planing mill in Los Angeles. Modern equipment will be installed.

The planing mill and box factory of the Brookins Lumber and Box Company, at Highland, Cal., was destroyed by fire. The plant will be immediately rebuilt.

The San Antonio Fruit Exchange, of Pomona, Cal., is making extensive improvements to its packing houses. New equipment will be added and enlargements made.

The George H. Lee Company, of Omaha, Neb., has leased property in Los Angeles, Cal., and will establish a factory for the manufacture of incubators and poultry products.

The California Gypsum and Plaster Company, of San Fernando, Cal., has begun the erection of a plant for the manufacture of its product at Choen Springs, on the Mojave desert, Cal.

The city of Oceansides, Cal., has voted bonds to the extent of $20,000 for the improvement and extension of the municipal water system. Bids will be advertised for in the near future.

Power-plant equipment will be required in the new hotel, the Burnham-McMurtrie, to be erected at San Diego, Cal. The structure will cost $125,000. MacDonald & Applegarth, San Diego, architects.

The Amazon Knitting Mills Company, Muskegon, Mich., has had a representative in Los Angeles, Cal., considering the advisability of establishing cotton mills in that section for the Imperial Valley products.

The Southern California Edison Company is planning to erect a building at the site of its gas works at Riverside, Cal. This structure will house necessary apparatus for its high-pressure system and will enable the company to supply Arlington, seven miles distant, with gas.

The Mt. Hood Railway and Power Company, Portland, Ore., promoted by E. P. Clark, of Los Angeles, Cal., will immediately begin the erection of a power plant to supply current to this road which will connect Portland with Mt. Hood. The road is now in course of construction.

CANADA

A large electric substation will be built at Winnipeg.

Gleichen, Alberta, will install a new system of waterworks.

Oakville, Ont., will spend $20,000 for new waterworks machinery.

James Malcolm is building a large wagon factory at Nelson, B. C.

The Coalette Company will locate a large plant at Fort William, Ont.

The Modern Pressed Brick and Stone Company will locate at Winnipeg.

St. Hyacinthe, Que., will spend $60,000 for new electric-lighting apparatus.

Collingwood, Ont., will install a producer-gas plant in its new power house.

Winnipeg is calling for tenders for a motor car for use on standard-gage track.

The Canadian Patent Scaffolding Company will locate a new factory at Toronto.

The Conduit and Cable Company, Limited, will locate a new factory in Toronto.

The Battle Creek Toasted Corn Flake Company, of London, will double its plant.

The Modern Pressed Brick and Stone Company will locate its plant at Winnipeg.

The Toronto Type Foundry will build a branch factory at Wynyard, Saskatchewan.

The Canadian Dredging Company, of Midland, Ont., is in the market for apparatus.

The Imperial Tobacco Company, of Montreal, is making large extensions to its plant.

The Canadian Box and Barrel Company will build a large factory at Pembroke, Ont.

Yorkton, Saskatchewan, is in the market for complete equipment for an electric-light plant.

W. Leger, of Eastview, Ont., will greatly enlarge his planing mill and put in new machinery.

The Office Specialty Manufacturing Company is building a large factory at Newmarket, Ont.

The Urban and Rural Telephone Company, of Bothwell, Ont., will buy a large quantity of supplies.

The Shell River Lumber Company will equip a large new mill at Prince Albert, Saskatchewan.

The Big River Lumber Company, of Big River, Saskatchewan, is making large extensions to its mills.

The Reid Newfoundland Company is building a very large car-building shop at St. Johns, Newfoundland.

Charles Reid & Sons, of Hamilton, manufacturers of paper boxes, will spend $300,000 extending their plant.

Prince Albert, Saskatchewan, will buy two centrifugal, electrically driven, automatic control sewage pumps.

Watrous, Saskatchewan, is in the market for equipment for a new electric-lighting system and a new car line.

The Dorchester Peat Company, of London, Ont., will buy machinery for developing extensive fields in the district.

The Canadian Collieries, of Comox, B. C., will spend $1,000,000 developing electrical power on the Puntledge river.

The Vulcan Tube Cleaning Systems, Ltd., will locate a plant at Montreal to manufacture appliance for cleaning boilers, etc.

The Alberta Central Railway, of Alberta, is in the market for equipment for its new line from Red Deer to Rocky Mountain House.

Fifty thousand dollars worth of machinery, destroyed by fire in the Goderich Organ Company's factory at Goderich, Ont., will be replaced at once.

Business Items

C. U. Scott, Davenport, Iowa, has established a plant for hardening high-speed steel for those not equipped for such work.

The offices of the Hawley Down Draft Furnace Company have been moved to its new factory at 736-8 West Monroe street, Chicago.

Trade Catalogs

J. J. McCabe, 30 Church street, New York. Circulars. 2-in-1 double-spindle lathe. Illustrated.

Link-Belt Company, Nicetown, Philadelphia, Penn. Book No. 102. Maximum silent chain. Illustrated, 40 pages, 3½x6½ inches.

American Locomotive Company, 1886 Broadway, New York. Catalog. Motor trucks. Illustrated, 32 pages, 8x11 inches, paper.

Modern Tool Company, Erie, Penn. Bulletin G. Plain, universal and internal grinders. Illustrated, 20 pages, 6x9 inches.

Oneida Steel Pulley Company, Oneida, N. Y. Catalog, No. 4. Steel and wood pulleys. Illustrated, 48 pages, 6x9 inches, paper.

Knox Automobile Company, Springfield, Mass. Catalog. Commercial motor vehicles. Illustrated, 38 pages, 7x10 inches, paper.

Joseph T. Ryerson & Son, Sixteenth and Rockwell streets, Chicago, Ill. Catalog. Emery-wheel machinery. Illustrated, 16 pages, 8½x11½ inches, paper.

The Adams Company, Dubuque, Iowa. Circular No. 701. Farwell quick-change miller. Illustrated. Circular No. 811: No. 3 Farwell gear hobber. Illustrated.

The Triumph Electric Company, Cincinnati, Ohio. Souvenir Bulletin. Inspection of new plant of the Triumph Electric and Triumph Ice Machine Companies. Illustrated.

Forthcoming Meetings

International aviation meet, Belmont Park, Long Island, October 22 to 30. Auspices of the Aero Club of America, 29 West Thirty-ninth street, New York City.

National Machine Tool Builders' Association, annual meeting, October 25-26, Hotel Astor, New York. Chas. E. Hildreth, secretary, Worcester, Mass.

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers, annual meeting, December 6-9, New York. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Foundrymen's Association, annual convention, Pittsburg, Penn., May 23 to 26, 1911. Richard Moldenke, secretary, Watchung, N. J.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Philadelphia Foundrymen's Association; meetings first Wednesday of each month, Manufacturers Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

The "Gas Saver" brazing forge; circular. J. L. Lucas & Son, 2 Fox St., Bridgeport, Ct.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Wanted—Medium weight specialties or contract work. Wm. A. Cather, Pottsville, Penn.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Let us be your factory; anything in metal; small work a specialty. P. O. Box 284, Anderson, Ind.

Will Mr. Brown Jackson communicate with Ed. Montague, Supt. Holm's Machine Mfg. Co., Sparta, Mich.

If you want special machinery or tools designed, I can give you satisfactory service. Box 39, AMERICAN MACHINIST.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—One second-hand boring and turning mill in first-class condition; 60-inch swing, two heads on cross rail. Box 21, AM. MACH.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Machinery and manufacturing plants, designed, constructed, examined and reported on. A. W. Jacobi, Engineer, 192 Market St., Newark, N. J.

Large English firm of machine tool importers having showrooms and offices in Great Britain, France, Germany, Italy, India and Japan is wanting good agencies for machine tools of all kinds. Box 189, AMER. MACH.

Inventor, Swiss, seeks manufacturers or capitalists to market or work numerous mechanical inventions in America; big profits assured. Address, preferably in French, the inventor, Henry Heitzmann, La Roserale, Geneve, Switzerland.

Notice—We have a large capacity and exceptional facilities for manufacturing, that involves sheet metal, brass foundry and electroplating work; will manufacture on royalty or other equitable basis. Address The Conneaut Company, Conneaut, Ohio.

Wanted—160,000 lineal feet of square pipe or tubing, 1¼x1¼x1/16 inches thick, to be used for cross-piling strips between lumber; manufacturers will be put into communication with purchaser by addressing "X Y Z," Box 62, AMERICAN MACHINIST.

Those breaks on power plant or machinery! Are you going to lose time awaiting new parts from makers, or will you let us weld them at one-fourth to three-eighths cost of replacements? Re-shipment within 24 hours. Oxy-acetylene process, producing homogeneous weld of cast iron. No charge unless successful. Waterbury Welding Works, Waterbury, Conn.

Wanted—Partner with twenty-five thousand dollars or machine shop and some cash against advertiser's five thousand and inventions to manufacture line of machinery paying fifty per cent. profit; advertiser now receiving five thousand yearly as manager in same line, in which he has had twenty-four years' experience as apprentice, machinist, patternmaker, draftsman, designer, salesman, salesmanager; designs for four machines completed; would consider buying small modern machine shop on easy terms, preferably in the East. Address "B. C.," AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Mechanical draftsman on jig and tool design and general mechanical shop

equipment; give particulars of previous experience and salary expected. Box 70, AM. M.

Wanted—Mechanical engineer, thoroughly experienced in crane work to take charge of crane department and other mechanical engineering work; applicants should state age, education, experience and references. Dominion Bridge Co., Ltd., Montreal, Que., Can.

INDIANA

Wanted—Four operators for Gleason bevel gear generators; four operators for Bilgram bevel gear generators; six operators for Brown & Sharpe automatic spur gear cutters; also one man capable of producing results that has had experience in all gear cutting lines, that would be capable of taking charge of large gear cutting department; none but first-class men need apply. 423 Johnson Block, Muncie, Ind.

MASSACHUSETTS

Experienced cost clerk wanted; must have thorough knowledge of cost finding in machinery line; state age, experience, salary expected and references. Box 56, AMER. MACH.

Responsible position wanted by a practical shop man, expert toolmaker and designer of special machinery and equipment, with wide experience. Box 58, AMERICAN MACHINIST.

First-class chucking hands, general machinists, gear cutting experts, and working foreman, for night work, by uptodate factory near Boston; five nights per week, Monday to Friday; best wages to satisfactory men. Box 59, AMERICAN MACHINIST.

MICHIGAN

Wanted—A thorough, capable and experienced mechanic to take charge of manufacturing a line of milling cutters and small tools; ability to design cutters and answer correspondence very essenial; must be a hustler with a thorough knowledge of the operation of modern machine tools and a good producer in quantity of high grade work; for consideration apply confidentially, giving age, nationality, education and salary expected. Box 28, AMERICAN MACHINIST.

NEW YORK

Wanted—First-class toolmaker, experienced on plumbers' brass work; give experience, reference and salary expected. Box 71, AM. M.

Toolmakers Wanted—Large firm will pay 45c. per hour to first-class men; give age, experience and reference. Box 30, AM. MA.

Wanted—Foreman for machine tool department, about 50 hands, steam and gas engine factory; applicants must be thoroughly experienced in handling men and equipment; state age, experience and references. Box 15, AMERICAN MACHINIST.

Mechanical engineer to prepare engineering data from manufacturers' catalogs; consulting engineer who could devote part time to work might answer purpose; must have capacity for compiling facts in tabloid form. Address "E. G.," AMERICAN MACHINIST.

Wanted—Assistant superintendent wanted for automobile factory; must have practical knowledge of machinery, be a hustler and good producer in quantity of high-grade work; give full information as to experience, etc.; applications treated strictly confidential. Box 31, AMERICAN MACHINIST.

Wanted—Salesman experienced in machinery or electrical lines to sell new line of portable electric tools on liberal commission basis; will allow definite territory to the man who will really work it; we know what can be done with this line and want a hustler to do it. Box 946, AMERICAN MACHINIST.

Wanted—A first-class man as assistant foreman in a large grinding department, doing a line of accurate, automobile work; only a man who has had experience as a foreman will be considered; no applications will be considered unless they give the following information: age, birth place, married or single, experience, names of firms by whom applicant has been employed during past seven years, in what capacity, wages expected to start, and when available. Address "Accurate," AMERICAN MACHINIST.

OHIO

Wanted—Salesman experienced in selling machine tools, milling cutters and small tools; state experience and qualifications fully; specify age and compensation required; must actually be employed in a similar line and a hustler with A-1 recommendations; location, Middle West; applications treated strictly confidential. Box 27, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Wanted—Lathe, boring mill and floor hands for day and night work. Address the Jeanesville Iron Works Company, Hazleton, Penn.

Wanted—Two first-class draftsmen, on power plant and substation work. Send application, stating all details to Box 55, AM. MACH.

Electrical or mechanical engineers wanted for hydroelectric development work; applicants must be neat draftsmen, preferably with experience in this line. Address application with full particulars to Box 54, AMER. MACH.

Wanted—Skilled mechanic capable of constructing by hand, experimental models of delicate electrical instruments and meters; must have served full apprenticeship and be well experienced; good position for proper party; state experience and salary expected when answering. Box 18, AMER. MACHINIST.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Draftsman, experienced, practical designer on tool and general machinery; at present on automobile tool designing; capable of taking charge; will go anywhere. Box 68, AM. MA.

Superintendent or factory manager, thoroughly conversant with modern methods in manufacturing light or medium interchangeable work; twelve years' executive experience. Box 41, AMERICAN MACHINIST.

GEORGIA

Machine shop foreman desires change; good references. Box 32, AMERICAN MACHINIST.

ILLINOIS

Mechanical engineer (30), university graduate, nine years' varied office and shop experience, cranes, hoisting machinery and general engineering, desires to change for responsible position in engineering or sales department; A-1 designer and good executive ability; location immaterial. Box 57, AM. M.

Situation wanted as mechanical superintendent; will go to any State in the Union; age 35; experience seven years in auto line, 10 years in stationary engines, pumps and air compressors; also the author of the double "S" system which I will install if so desired; at present I am with a large automobile house acting as assistant manager. "S S," Box 60, AMERICAN MACHINIST.

MASSACHUSETTS

Factory manager, successful, experienced in organization, cost and factory systems, desires change; can produce results and stand on own record, and give best references from present and past employers, also satisfactory reason for changing. Box 9, AMERICAN MACHINIST.

American, 41 years of age, 23 years' experience as manager, superintendent, systematizer, chief designer on drop forge, die sinking, die making of all kinds and complicated machinery, hustler, 16 years with one company, but desires change; best of references. Box 47, AMERICAN MACHINIST.

High grade designer, extensive experience on tools and automatic machinery for manufacturing interchangeable parts; good mechanic and executive, conversant with office and factory details, wishes responsible position offering good prospects; best of references from present employer. Box 63, AM. M.

NEW JERSEY

Mechanical engineer, chief draftsman and designer, steam, hydraulic and special machinery, is open for engagement. Box 71, AM. M.

General foreman, 39, now engaged, accustomed to modern methods of manufacture, desires change. Box 61, AMERICAN MACHINIST.

Superintendent and factory manager, high class, hustling and efficient; expert on tools, dies, gages, machine building interchangeable parts, foundry structural steel and sheet metal products; thoroughly understands handling help, hustling out work, speed and production my specialty; never failed to exceed all expectation; superintendent twelve years. Box 64, AMERICAN MACHINIST.

Master mechanic, 38, several years' experience as foreman, capable of better job and wants it; knowledge of all around manufacturing; expert toolmaker, designer, inventive, adoptive; some technical knowledge, self acquired; good general education; some selling experience; inventor of a practical monoplane; present salary $1720. "Ambitious," Box 50, AMERICAN MACHINIST.

Wanted—Position as manager, or assistant manager of machine tool plant or machine shops, or would put experience against capital in a partnership; over 19 years' experience as machinist, toolmaker, foreman, inspector, demonstrator on road, estimator, designer, chief draftsman and assistant engineer; age 36; permanent position only considered; salary $2500; I can make good. Box 48, AM. M.

NEW YORK

Mechanical engineer, 12 years' experience along broad lines, is open for engagement. Box 22, AMERICAN MACHINIST.

Mechanical and structural draftsman, ten years' shop and office experience, technical graduate, desires position, New York vicinity. Box 25, AMERICAN MACHINIST.

Draftsman and chemist, Swede; three years' experience in brass and copper concern. Address "R. H.," AMERICAN MACHINIST.

Correspondence solicited with concern in need of services of engineer and designer; over twenty years' experience; has held positions of trust for many years. Box 5, AM. MACH.

Mechanical superintendent of a large manufacturing plant, with twenty years' experience in general machine and foundry practice, desires making a change. Box 901, AMERICAN MACHINIST.

Chief draftsman or superintendent; age 37; 15 years' experience, both machine shop and foundry; light and heavy work; competent to take complete charge. Box 52, AMERICAN MACHINIST.

Mechanical engineer, experienced in experimental work and developing of ideas; also in originating and designing new machinery and devising means and methods of doing work systematically and cheap. Box 67, AM. MA.

Mechanical superintendent, superintendent of maintenance; superintendent of power plant or consulting engineer; assume full charge of power plant, manufacturing machinery, buildings, etc.; capable of taking a load off manager's shoulders; first-class mechanical engineer, experienced, good education, will consider other mechanical, executive or confidential position; willing to travel, but no salesman's position wanted; bonds if needed; be explicit in your reply. Box 933, AM. MA.

OHIO

Wanted—Position as sales manager or salesman on commission basis only for standard line of machinery or tools; specialty line preferred. "Executive," Box 69, AMER. MACH.

Production engineer with 12 years' experience in responsible manufacturing and commercial positions, desires position as manager or superintendent. Box 66, AM. MACH.

PENNSYLVANIA

Cost accountant, thorough experience in machine shops and foundries, desires to change; references. Box 65, AMER. MACH.

Machinist, with four years' experience designing machine tools and jigs, drafting position in Middle West preferred; age 26. Box 49, AMERICAN MACHINIST.

Foreman, middle aged, now employed, latest methods, engineering, dynamos, electrical and general machinery; A-1 hustler; can handle force with executive ability. Box 33, AM. M.

RHODE ISLAND

Position by an expert mechanic as foreman, tool or machine room; 21 years' experience as machinist, draftsman and designer, toolmaker, foreman, etc., on highest grade interchangeable work. Box 19, AMER. MACH.

FOR SALE

For Sale—Very reasonable, almost new, boring bars: 8"x10', 6½"x9' 6", 3½"x4' 2", 2½"x3' 8½", with steam engine and complete set of patterns for casting of bars; can be seen at Hoboken, N. J. Address "Bargain," Care AMERICAN MACHINIST.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business: it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

Talks With Our Readers

By the Sales Manager

American Machinist,
505 Pearl Street,
New York City.

Gentlemen:—

During the past two days one of your representatives has been making a personal canvass among the men in our shop trying to induce them to subscribe to the "AMERICAN MACHINIST." This has been done during working hours because his chances during the noon hour were so slight that they were almost negligible. This represents an expenditure on our part equal to the number of hours spent by your representative multiplied by the average hourly rating.

In return for this we would like, if your business policy will permit, to have the names of all those in our shop who are subscribing, or who subscribed to the "AMERICAN MACHINIST," because of the inducements offered by this representative. Our reason for asking this is that we believe the progressive ones are those who do subscribe to this sort of a paper, and we want to know who the progressive ones are so that when the opportunity for advancement comes they may be the ones who will get the benefit of such opportunity.

Yours truly,
The Royal Tourist Car Co.
Robt. Jardine
Cleveland, O. Gen'l. Supt.

* * *

It is becoming easier and easier for our thirty-odd salaried subscription men and our local shop representatives to get the responsible men in machine shops to subscribe to the AMERICAN MACHINIST.

The progressive owners and managers realize that it is to their best interests to encourage its reading.

The race is to the swift these days and the concern who would keep abreast of the times must have its men keep posted.

As Mr. Dooley says, "These do be great times. They put up a twenty-story skyscraper today and tomorrow they tear it down to make room for a modern building."

The tool of today is the junk of tomorrow.

* * *

But these changes do not occur right under our own eyes—they are happening in all parts of the world. Every day a new idea is conceived and if placed at your disposal will prove of value to you.

Improvements in things mechanical are accomplished in an endless chain fashion. The men who work out great things begin where others left off—they start at the top of the ladder and build more rungs.

Those who are trying to do what has already been done have not been reading the AMERICAN MACHINIST — the weekly record of progress and the current encyclopedia of the machine-making field.

Some progressive concerns buy the paper for their best men. Others see that they read it.

More and more will do likewise when they appreciate the fact that a concern cannot be in the front rank unless it employs live men to put and keep it there.

Live men read carefully the live paper in their field.

* * *

Say you saw it in the American Machinist.

The Largest Valves in the World

Special Correspondence

Three 9-foot gate valves for the control of hydraulic turbines of 12,000 horse-power each.

The body is of cast iron and the gate of cast steel, the latter being raised and lowered by electric power, requiring three minutes for each operation.

What it is fairly safe to assume are the three largest gate valves in existence, have recently been constructed by the Chapman Valve Manufacturing Company, of Indian Orchard, Mass., for the Ontario Power Company, of Niagara Falls, Canada. These valves are 9 feet in diameter of water way, and each is to control the water to drive a hydraulic turbine generating 12,000 horsepower. It was found when one of the valves was completed that it weighed 130,000 pounds.

From the various illustrations a good idea of the size of the valve may be had. The overall hight is 30 feet 3 inches and the width is 11 feet. The total thickness over the flanges is 6 feet 8 inches. As shown in Fig. 3, a 14-inch bypass valve is provided for relieving the water pressure when opening or closing the valve. Fig. 2 shows the valve body mounted upon a flat car for shipment, and its size relative to the men and the locomotive will be appreciated. The two flat cars are required to handle the parts of one valve. In Fig. 4 is shown the cast steel gate resting in one-half of the cast-iron body, although the bronze shoe which goes between the gate and the guide is not in place.

In actual operation the valve gate will be under a pressure of 60 pounds per square inch, and the total load carried by the gate will then be more than 550,000 pounds. The gates are of cast steel and weigh close to 9 tons each. The valve bodies are of cast iron, heavily ribbed to withstand the pressure, and the valve seats are of bronze, these being held in the body by special bronze, headless screws through the ring face. The usual method of construction for the valve seat, that is, threading it into the body, was not deemed safe because of the heavy pressure around the periphery of the seat. It was feared that this pressure would cause the seat ring to collapse, and so the screws were used to give it a firm grip upon the valve body all around. Tightness between the bronze seat ring and the cast-iron body is assured by lead calking.

Guides are provided for the cast-steel gate, and brass shoes are suitably placed to take the wear between the gate and the guides. At the instant of closing, the valve gate is forced away from the guides and rests entirely against the bronze seat ring, the water pressure holding the gate tightly shut. This final seating upon the bronze ring is attained by putting the seat in on a slight angle, giving the effect of the wedge-shaped plug of an ordinary gate valve.

Raising of the valve gate is accomplished by two tobin-bronze spindles, 4½ inches diameter, with threads of 2 inches pitch. These spindles are 12 feet 3 inches long and are operated through gearing, by

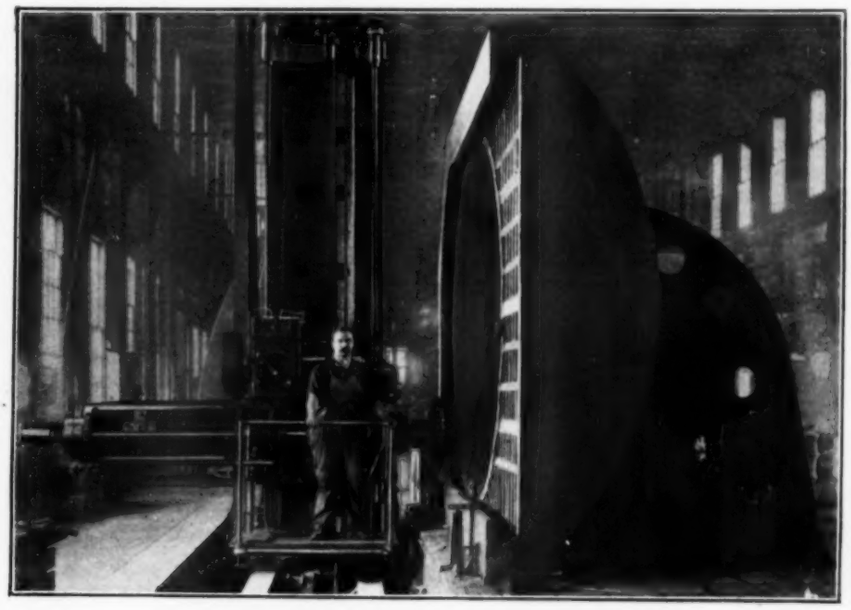


FIG. 1. HALF VALVE BODY ON SELLERS' MILL

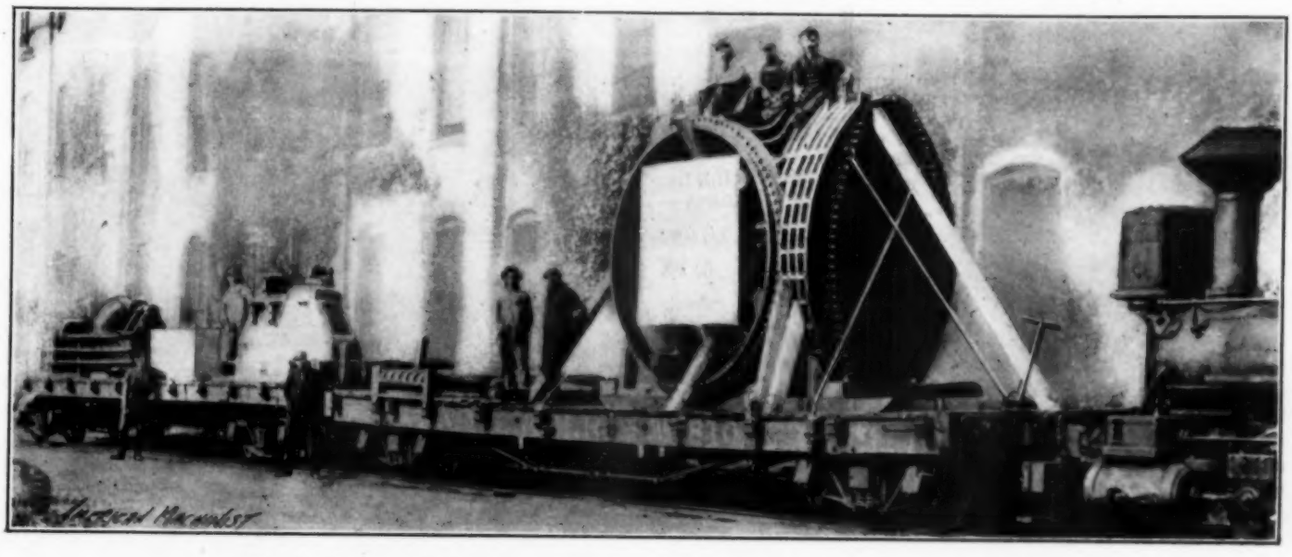


FIG. 2. COMPLETED PARTS OF ONE VALVE, REQUIRING TWO CARS FOR SHIPMENT

a 15-horsepower alternating current motor, 3 minutes being required to completely open or shut. To prevent thrashing and knocking of the spindles inside the gate as the former rotate, the spindle sleeves are bored in the cast-steel gate, to an easy fit over the spindles. Automatic limit switches are provided at the top and bottom of the gate travel and arrangements are such that at the end of this travel it is impossible to restart the motor in the wrong direction. If,

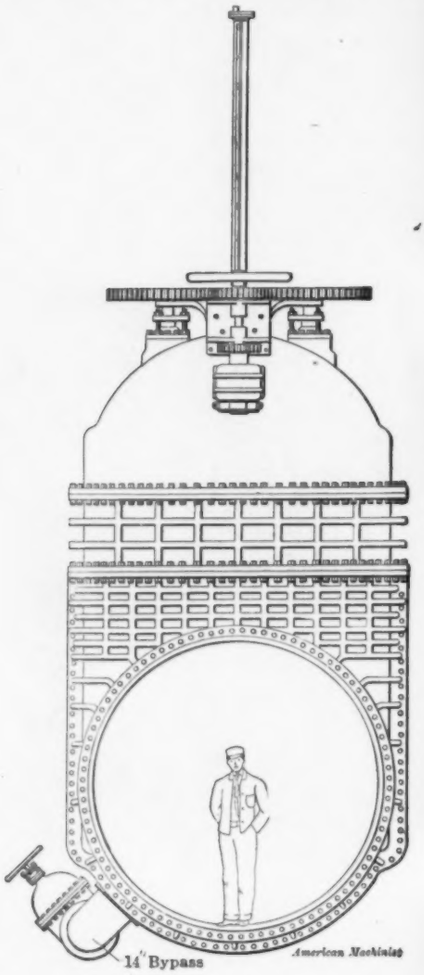


FIG. 3. APPEARANCE OF ASSEMBLED VALVE

however, the motor is stopped with the gate part way open or shut, the motor may be restarted in either direction. A magnetic brake also assures quick stopping of the mechanism.

MACHINING THE PARTS

As may be supposed the machining of valves of this size is of some interest. In Fig. 1 is shown the milling of the facing of one of the body halves, this work being done in the Sellers' mill. The large angle bracket at the back of the body, and bolted to the bed, keeps the body in an upright position, while the cutter is traveled over the U-shaped surface.

In Fig. 5 a rather interesting method of

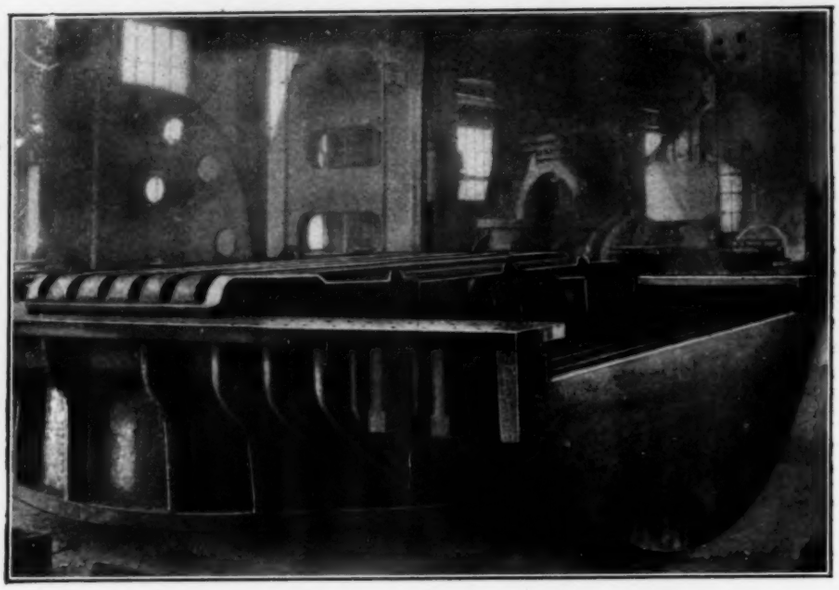


FIG. 4. GATE IN PLACE IN ONE-HALF OF BODY CASTING

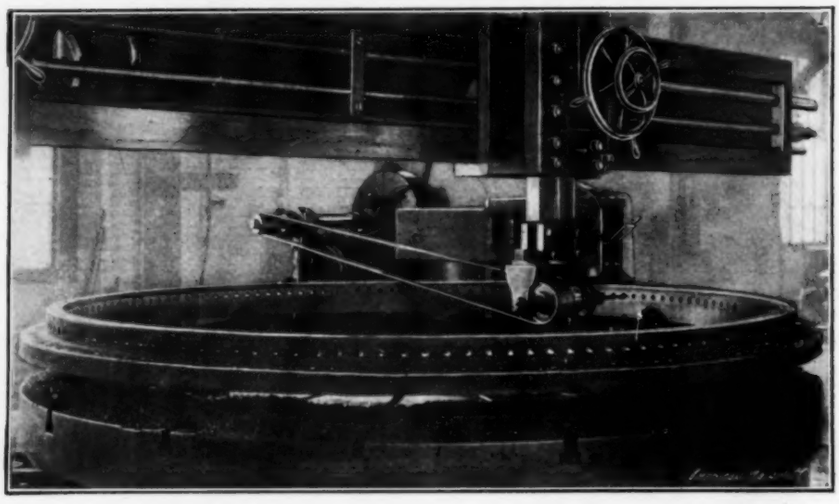


FIG. 5. DRILLING RIVET HOLES IN COMPANION FLANGE, IN BORING MILL

FIG. 6. FACING TOP FLANGES OF CAP

drilling the rivet holes in the companion flanges for connection to the penstock, is shown. Here, it will be seen that the headstock of the lathe is mounted upon the end of the ram of a large boring mill. The lathe headstock spindle carries a twist drill, belt driven from a back-geared motor at one side of the machine. The table of the boring mill acts as an index for rotating the flange between holes. Some idea of the size of the cap may be obtained from Fig. 6, where the flanges at the top of the spindle sleeves are being faced off.

The Molds

Making the molds for these large valves is of particular interest because a large part of the deep core work is in green sand. Fig. 7 shows the body mold in the foundry floor, with some of the pattern parts in the background. This pattern was made up in sections with the flanges and ribbing screwed onto the main part from the inside. The whole pattern was then rammed up in green sand, and then the pattern was dismantled from the inside by removing the screws and taking out the parts one at a time. Some parts of the pattern are still left in place in the view of Fig. 7, notably the flange ring at the bottom of the mold. This method of molding the valves obviated a great deal of dry-sand core work, as will readily be appreciated. In Fig. 8 the cope of the mold is seen with the cores suspended from it.

Fig. 7. Body Mold in Foundry Floor, Showing Green Sand Cores

Fig. 8. Cope of Body Mold, Showing Suspended Cores

The Cost of Making Things Oneself

By John R. Godfrey

One of the inborn tendencies of every mechanic is to make everything for himself. So in the older days, and not so very old either, we made over our own set screws and bolts, wooden file handles and any other old thing we needed.

So with small machines, and even large ones to some extent, and all sorts of attachments were invariably built in the shop wanting them, and all under the delusion that it didn't cost much of anything to build things yourself.

We have overcome this very largely in the case of most machines of any size and to some extent with attachments as well, but when it comes to some of the smaller supplies we are stiil very prone to go astray.

Small grinding wheels of emery or any other abrasive is a case in point, that came up in a shop I visited not long ago.

A large wheel had broken as they sometimes do, usually from careless mounting or using, and the economy bug had inoculated the foreman with the delusion that he could save money by using these as material for small grinding wheels.

So he had the corners knocked off to make the pieces somewhere near round, worked a hole through with difficulty and patience, and then proceeded to turn it round with a wheel dresser after which he trued it up with the diamond.

It made a pretty fair looking wheel too and he was proud of the job till an unfeeling salesman of grinding wheels happened around and opened his eyes.

He had used up about two hours of a good man's time, which came to at least 50 cents, had used the dresser, diamond, etc., which hadn't added a cent to their value, and the salesman showed him where he could have bought a wheel of the same size for 11 cents.

And worst of all, the large wheel wasn't at all the grade that he would have ordered for the small inside wheel. A large wheel on outside work is a very different proposition to the wheel for small internal work. And so it was a losing game all around.

High Line Shaft Speed

The Oliver Chilled Plow Works, South Bend, Indiana, have two line shafts running at a much higher speed than is usual. In one of their grinding departments there are two line shafts, each 100 feet long, which are direct connected to motors. The shafts are 2 7/16 inches in diameter and run 720 revolutions per minute.

The machines driven are all grinders, using 18-inch wheels and running at 1200 revolutions per minute. They are belted direct from the line shaft, having tight and loose pulley. The belt speed is approximately 1885 feet per minute.

The bearings are plain, with ring oilers and have been running about four years with very little wear and the shafting has had practically no attention.

A High Powered Close Drive

By John Squires

A well designed drill drive of high power for a special purpose where compactness was the important consideration.

Usually special tools and appliances are designed to primarily either make more profitable production possible, to promote a greater degree of accuracy, or to provide means to handle work of new design, but occasionally a combination of circumstances arises in some manufacturing process whereby synchronism of production is not attainable by the use of regular methods and some means must be devised by which a particular section of the work can be facilitated sufficiently so that it will not act as a drag upon the other elements involved.

The case presented here is peculiar in that the addition of another man to the assembly crew which had this particular piece of work in hand would not have improved matters, nor was it possible as will be seen, to use another tool.

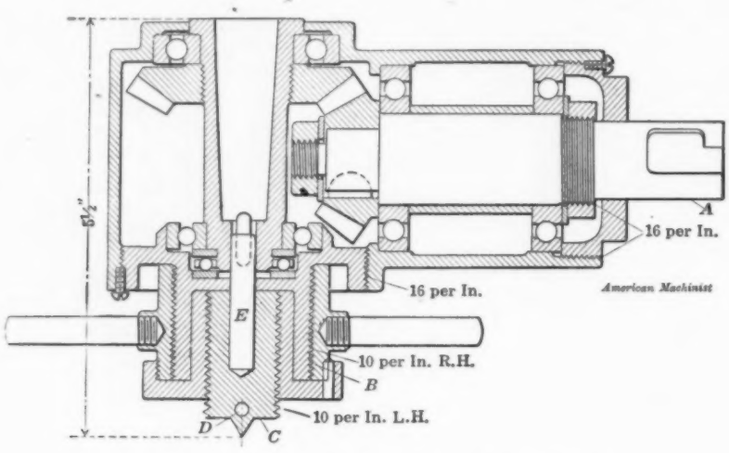


FIG. 1. A HIGH-POWERED DRIVE FOR CLOSE QUARTERS

The job in question was that of assembling power plants in motor chasses, on a schedule of two chasses to be completed per day. The rest of the work of assembling was divided up among two other crews, and was very nicely balanced, keeping them well on the jump to maintain the schedule.

The power plant assembly crew consisted, and does yet, of a first-class machinist and a good helper with every facility provided for handling the work expeditiously, and their work is to install the motor, clutch, transmission, drive shaft and control.

In our chassis the motor and transmission are hung independently, the motor having four legs extended from the crank case to the side members of the frame with the customary lugs resting on the top of the side members for support.

The transmission is some distance back from the motor and is hung from two cross members by three through bolts passing through lugs projecting from the transmission case, one at the front of the case and two at the rear.

The space between the cross members is only ten inches, and an electric drill powerful enough to drill a ⅞-inch hole, the size of the supporting bolts, is far too long to go into this space, making it necessary to ratchet these holes through by nand, the ratchet being the only thing short enough to go into this space, even with a specially shortened drill.

The time consumed by hand-drilling these holes made it necessary for the assembling crew to work over-time an hour and a half every night to maintain their schedule, which could not have been obviated, as stated above, by the addition of another man to the crew, nor was it possible to use another drill because of the necessity for keeping two of the lugs clamped while drilling the other one.

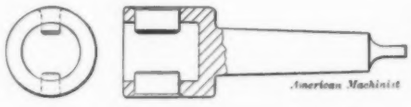


FIG. 2. A QUICK-ACTING SOCKET

Accordingly the market was canvassed for a right-angle drill drive that could be power driven for use in this space, and if there is any built we have as yet failed to find it, short or long. So we built a drive ourselves.

Knowing in advance that it would be necessary to get the full capacity of the drill to get inside the time limit, we went to automobile construction with the result shown in Fig. 1.

As shown in the figure, the length over all from the face of the drill socket to the point of the feed screw is 5½ inches, and allowing 2½ inches from the face of the socket to the point of the drill (we use a specially shortened one) makes a length over the whole of 8 inches.

The time required for drilling these holes now is approximately a minute and a half each, using a high-speed steel drill, that part of the time consumed in going through the cross member being a trifle slow as the material is heat-treated chrome-nickel steel. This has done away with overtime work.

The separate drive socket shown in Fig. 2 is used because a taper shank in place of the shank *A* would necessitate attaching the drive to the drill before setting it up, which would make it too cumbersome to handle. Ball bearings were used throughout because of their ease of lubrication and the case having no openings, one filling of graphite grease will last for months. The drill socket runs at half the speed of the driving shaft, making it possible to use a comparatively small-powered high-speed electric drill for power.

A comparatively long feed is obtained by means of the telescoping screws *B* and *C*. When feeding it is necessary to use an anchor pin in hole *D* to keep screw *C* from turning. *E* is an ejector pin driven into screw *C* and sliding through the adjacent parts, and serves instead of a drift to drive out the drills when changing.

As it is unquestionable that others must have felt the need at times for using power for drilling in close quarters, I offer this design as a suggestion of what may be done. The total cost of this tool was less than $25 (the bearings and gears were purchased from stock) and it has saved its cost many times over since we put it into service.

Manufactures now form, for the first time in the history of our commerce, more than one-half of the total exports of the United States. In the 8 months ending with August, the figures of the Bureau of Statistics of the Department of Commerce and Labor show that out of a total exportation of 1027 million dollars, manufactures amounted to 542¾ millions, or 52.8 per cent. of the whole. Steel and iron manufactured products are conspicuous in the list of articles, accounting for the increase.

Proposed Standard for Gear Teeth

Discussion in England

We have already given on pages 305 and 317 the papers on Interchangeable Involute Gearing, by Wilfred Lewis, and on A Proposed Tooth-gearing Standard, by J. D. Steven, both read at the joint meeting of the mechanical engineers in England, and we give below the major portion of the discussion as it appears in the October issue of the journal of the American Society of Mechanical Engineers.

A confession of ignorance regarding many features of the subject and a defense of the existing form of tooth for several purposes.

BY P. V. VERNON*

The speaker said he was present at the meeting as a patient and not as a doctor. He was connected with a firm of machine-tool makers, which had made many long and costly experiments with a view of determining, not what he might call academic points in the design of gearing, but for the purpose of obtaining a system of gears that would run silently at high speeds. His object in speaking was to ask that something might be done to discover the points that would give silence in gears, as until gears could be obtained which ran silently the question of making them interchangeable could hardly be profitably considered. The results of the experiments which his firm had made had been very small in the way of positive knowledge, but they had been very great negatively in the way of teaching them how very little anybody really knew about gearing. Among the negative results were the following: In the first place, it appeared that there was no general agreement among engineers or gear makers as to the best angle of pressure to use; there was no general agreement as to the proportions of gear teeth which were the best for quiet running; there was no reliable information on the strength of cut teeth made by modern methods in various materials and running at various speeds; there was no reliable information at present available on the effect of different materials on the strength, the noise, and the wear of gear teeth. It appeared, in fact, exceedingly' doubtful whether it was possible to make an interchangeable system of gear teeth at all for quiet running.

Previous speakers had stated that the involute system was imperfect; engineers knew that the epicycloidal system was dead; and the results of the experiments which his own firm and others had made had proved that involute teeth did not give a quiet gear; that epicycloidal teeth did not give a quiet gear; that hobbed gears were not quiet, and that planed gears were not quiet. But there was one kind of gear which was quieter than all those, namely, the gear with "faked" teeth. It now was well known that the gears which gave the quietest results in running were those on which an empirical correction of the tooth form had been made, and so far as he knew the means by which that correction was made were kept secret, and were in the hands of one leading American firm, of which a representative was present at the meeting. When Ralph E. Flanders read his paper before the American Society in December, 1908, this same representative of that firm practically admitted that the only way to get quiet gears was to make an empirical correction on an experimental basis, and that the best thing for gear users to do was to trust to the experience of that firm, which he (Mr. Vernon) supposed meant to buy their cutters from them. He spoke at that meeting as a member of both the Institution of Mechanical Engineers and to The American Society of Mechanical Engineers, and wished to say that although the greatest credit was due to that firm for having made their investigations and experiments, it was not to the interest of gear users in America and in England that that knowledge should continue to remain in their hands alone. He hoped the remarks he had made would do good by bringing the Committee of the American Society of Mechanical Engineers, who were considering gear questions, into touch with the committee of the Institution of Mechanical Engineers, so that investigations might be started with a view to ascertaining what were the corrections which needed to be made to insure quiet tooth action, and so that such information, when obtained, could be placed in the hands of gear users in both countries.

*Chief designer, Alfred Herbert, Limited, Coventry, England.

BY C. R. GABRIEL*

This discussion was prepared at the request of the Meetings Committee of the American Society of Mechanical Engineers as a contribution upon standards for gears, and is submitted as a personal opinion, rather than a report, as the findings of the committee up to date have not established definite conclusions.

As stated, the committee received in reply to its circular letter, a large number of answers, but few contained comparative data and were largely expressions of theories or opinions, such as most engineers have advanced in explanation of the difficulties arising from improperly cut and noisy gears. The expression "improperly cut" is used advisedly, as from an experience covering a long period of years the writer believes that nine-tenths of all the trouble with noisy gears can be attributed to improper cutting.

As regards the adoption of a standard, the opinion of the writer is that the present so called Brown & Sharpe standard will hold its own against any system for the general run of machinery; and that for many of the cases where special cutters or forms of teeth are used, the benefits of such modifications are more imaginary than real. The answer to the difficulties arising where high speed, durability and efficiency are required, will be found in the substitution of better material and better methods of treating in the hardening process.

The present system is called by some an empirical one, but any carefully worked-out system will be so, as practice shows that decidedly better results are obtained by certain modifications of the theoretical tooth form. Teeth having an increase of pressure angle and reduction of addenda to prevent undercutting on 12-tooth pinions would be subject to the same modifications which would put them in the empirical class, and any manufacturer of cutters would undoubtedly strive to improve his cutters regardless of whether they were strictly in accordance with theory.

The opinion is expressed that if such modifications are necessary, the methods should be known and clearly defined, so that makers of gears can use them and make their own cutters, if necessary. The advantages to the gear manufacturer of making his own cutters are not apparent to the writer, as the difficulties attending the making of form cutters would prove expensive in comparison with the convenience of using commercial stock cutters produced by reliable cutter manufacturers.

Attention has been called to the increasing number of gears cut by the hobbing process, and the difficulty of making such gears interchange with certain cut gears, thus demonstrating that the hobbing principle is the one to which all cutters should conform. This seems misleading, as the fact is not mentioned that this process has its limitations. It must not be overlooked that one great disadvantage arises from the difficulty experienced in producing accurate hobs.

The method of producing gear teeth by the shaping process has also been actively exploited, and the committee's atten-

*Designing engineer, E. W. Bliss Company.

tion has been called to the fact that it is an incidental feature of this process that the regular standard 14½-degree cutters (on account of the side strain involved) are less durable than the usual form of revolving cutter, especially under rapid production requirements, and in tough material. The proposed 20-degree pressure angle stub tooth materially increases the strength of the reciprocating gear-shaper cutter. The writer also calls attention to the fact that the stub-tooth system would greatly reduce the difficulties in producing the hobs for the hobbing process referred to above, and believes the committee should be very conservative in its recommendations, particularly where they appear to favor some method or methods of producing gear teeth.

As regards the forms of teeth referred to in the paper as submitted by the other members of the committee, Mr. Fellows proposes to use an involute with 20-degree pressure angle, and an addendum of ¾ of the modulus. Mr. Lewis proposes an involute with 22½-degree pressure angle, and an addendum of ⅞ of the modulus. Both of these systems are subject to criticism for general adoption, (*a*) because of increased angular backlash, as compared with the present 14½-degree standard for a like amount of wear; (*b*) decrease of addendum which is decidedly objectionable on the smaller pitches, as the liability of error in depth of tooth and center distance of shafts remains a constant for all pitches and sizes of gears, and the present hight is none too great, being increased for these reasons for some purposes.

Further, it is claimed for the stub-tooth system that the arc of contact is equal to that of the 14½-degree Brown & Sharpe standard, and that consequently the excess of tooth hight in the standard system produces unnecessary friction and wear, which is eliminated in the stub-tooth system. The fact is not mentioned that in the Brown & Sharpe system the hight of tooth permits of being eased off toward the point, with the result that it causes no friction if the integrity of the tooth form is maintained, but as wear cannot be entirely eliminated this easing of the points of the teeth allows the engaging teeth to come into action without shock, thus reducing noise and the dynamic action which tends to destroy the gears by the contacting of the teeth and is similar to hammer blows. Also, in practice the standard length of tooth will conjugate itself with its mating gear, with the result that more than one set of teeth take the load. This may produce extra friction, as claimed, but with properly lubricated gears this is a negligible quantity, as the unit stresses are divided over more than one set of teeth. The stub tooth has greater strength, but, for the reason cited above, does not prove as satisfactory for all-around service.

In this connection, the writer wishes to refer to the situation in motor gears used in street-car service. From personal observation he has seen stub-tooth gears where this dynamic action seemed to have broken down the structure of the steel to such an extent that it came off in splinters where the points of the teeth seemed to have bitten the material away. The best results the writer has seen in this class of work are where gears and pinions have been cut to the Brown & Sharpe system and carbonized and case-hardened, with the result that after a year's use there was only glazing of the contact surfaces.

As to the matter of testing, the committee are united on its desirability, but the writer does not believe that anything definite or conclusive can be obtained from testing a few pairs of gears. The tests should cover a large number of gears of more than one pitch and of several different ratios of teeth. These tests should be so exhaustive as to leave no opportunity for engineers to feel that anything has been assumed. This means great expense and much time, and the writer would recommend that the coöperation of all interested parties be secured, that a fund be raised for the purpose of employing competent engineers to conduct exhaustive tests with suitable apparatus, and that all available materials be used, so that the differences of opinion as to the efficiency of the various systems in use may be set at rest as far as possible. Also this should furnish reliable data for proportions of gears of the various materials, now mainly a matter of judgment with the designing engineer, from which more gear failures result than from any fault of the system of teeth used.

To sum up the situation, the writer believes that where the limits of an interchangeable system are from a 12-tooth pinion to a rack, the present system is superior to any which are primarily based on the generating principle, in which the pressure angle and tooth parts are proportioned to facilitate the methods of producing and strengthening the cutting tools, rather than to improve the interchangeability or more quiet running of the gears, as that is a fact still to be demonstrated. The circular letter sent out by the committee brought out the information from one concern that it had experimented exhaustively with the hobbing system for a long time, with various tooth forms, but had gone back to the Brown & Sharpe standard, for which they had worked out a most satisfactory method of making the hobs. This is another example of the working out of an empirical system, and any satisfactory system covering the range stipulated, which, as before stated, must be an empirical one, had best be left to responsible cutter manufacturers whose methods combine the theoretical with the practical. The present Brown & Sharpe system has proved itself eminently satisfactory for many years, and without most thorough investigation should not be given a place second to any other. Also the introduction of an alternative standard or standards is to be deprecated on the ground of causing confusion and economic waste, due to the increased stock of cutters required for use on all types of machines.

In conclusion, the writer wishes to refer to the point raised in some of the replies to the committee's letter, that the question of standardizing gearing is of the same nature as screw-thread standardizing, and can be treated in the same way. Without referring to the conclusions reached by the Committee on Screw Threads, the deliberations of which consumed several days, the writer fails to see wherein the problems set forth by the two subjects can be compared. The screw-thread situation was one to be settled by common consent of all concerned, while the problem of gearing is one that is worthy the life work of any engineer, and involves much of the higher mathematics of engineering, as well as a thorough knowledge of applied kinematics. The fact that such a comparison has been made by some writers on the subject, only serves to show an utter lack of appreciation of the magnitude of the problem set before the committee for its consideration and recommendation to the Society.

By L. D. Burlingame*

Mr. Burlingame said he appreciated all Mr. Vernon had said with regard to their policy at the Brown & Sharpe works, but he thought the point which had been raised was very well answered by the communication of Mr. Gabriel to which the members had just listened. Speaking for a manufacturer, at whose works for more than 60 years an extensive business in making gears and gear-cutters had been done, and which had had to deal with all phases in the gear question and meet the varying requirements of customers during those years, he could say they were not surprised that the different members of the committee of the American Society of Mechanical Engineers were not unanimous as to any plan which would bring about a change from the present standard. The thought seemed to be uppermost in the minds of those proposing a change that a standard should be adopted having a true involute for the entire length of the tooth, even if sacrifices in other directions must be made to accomplish that result. He believed the advantage, if any, of having the entire tooth a true involute was less than they would be led to believe by those advocating a change; indeed it was a matter yet to be demonstrated that the practical advantages of the form of tooth now in common use would not more than outweigh any theoretical advantage of a tooth wholly involute. The fact that the

*Chief draftsman, Brown & Sharpe Manufacturing Company.

special requirements at the present time were for teeth varying both ways from the present standard would indicate that they now had a good average to meet ordinary working conditions. Their experience went to show that for quiet running for a possible variation in center distance and to avoid back lash, a small pressure angle and long teeth were of advantage, while for cases in which strength was the prime consideration, even at the sacrifice of other advantages, the greater pressure angle and shorter teeth had their field of usefulness. Those varying needs were illustrated in automobile practice, where in some makes the cam-shaft gears were made with a small pressure angle and long teeth, while the driving gear was made with a larger pressure angle and shorter teeth, in each case for the reasons he had previously referred to. That strength in the latter case was secured at some sacrifice was indicated by the illustration used by Mr. Gabriel in his communication, where he spoke of the injurious effects of the hammer-blow action when "stub-tooth" gears were used in street-car service. The same destructive action had been noticed in stub-tooth gears used for automobile service. An engineer who had for many years made a specialty of gearing, and who was an expert on that subject and who had in recent years been with one of the leading automobile manufacturers of America, told him he had repeatedly found the same destructive action spoken of by Mr. Gabriel when stub-tooth gears were used in various makes of automobiles.

Mr. Lewis, in referring to the preliminary tests made by the students of the Massachusetts Institute of Technology, said they showed that the loss of friction was varied to a greater extent by the length of the addendum than by the angle of obliquity. As he understood, the tests to which Mr. Lewis referred were made entirely with roller bearings, thus reducing the bearing friction to a minimum. That friction, however, was one-third greater for the 20-degree pressure angle than for the 14½-degree angle. With plain bearings the friction on the bearing would be much greater than with roller bearings, that factor favorable to the smaller pressure angle might more than offset any advantage shown by the tests in favor of the greater pressure angle as reducing friction. As plain bearings were more extensively used than roller bearings, the tests could not be considered complete without securing full data when using plain bearings. He agreed fully with Mr. Gabriel as to the need of exhaustive tests by competent engineers before any result could be accepted as authoritative.

He wished to take the present opportunity of indorsing what Mr. Gabriel had said relating to other phases of the subject. He did not believe that any modification of the present standard which would require more cutters in a set to insure good running gears would meet with favor among manufacturers, as it would add directly to the cost of the equipment. All of the pla . suggested in Mr. Lewis' discussion were such as would require extra cutters in the set. Neither did he believe that any plan would be generally approved which would increase the amount of back-lash with a given variation in center distance or with a given amount of wear. Unless some very important advantages could be shown for some new system yet to be suggested, it would seem unwise to bring about the confusion which would result from a change not fully indorsed by the manufacturing public.

Purifying Cast Iron in the Cupola

By F. Scott Anderson

A process that can be applied in regular cupolas that has the effect of obviating brittleness in common pig iron.

A new process has been most successfully worked in England for the purification and improvement of cast iron in the cupola. Any ordinary cupola can be employed, if a "receiver" is, or can be, attached.

An air pressure of some three to five pounds per square inch is employed, and the necessary tuyere pipes are fixed, the number and size of which are controlled by the capacity of the cupola. A "bath" or "well" is arranged at the bottom of the cupola, and a taphole is provided, by which the molten metal from the bath can be tapped after the blow is completed. At the top of the bath an outlet to the receiver is also provided. Other air pipes are employed at the top of the bath, to assist in combustion and heating.

Three such pneumatic cupolas were erected, 18 months ago, in the works of a large maker of gas and oil engines, and the experience obtained in these works is best shown by giving the following extracts from a letter:

"Before using your system we employed a pig iron costing $20 per ton, and even with this iron we were at times troubled with porous castings, and several were rejected.

"Since installing your process, we have used a pig iron costing only $15.25 per ton, and with it are turning out a perfect, nonporous and sound casting, and our losses do not exceed 3 per cent. per month. We are at the same time saving one-third of our previous coke bill, and we are entitled to affirm that the process is in every way satisfactory to us.

"As to the change which takes place in the iron, we consider that it is essentially a physical one; but is is such as to afford us every confidence in the process."

The same cupola produces the finest malleable castings, and by adding an additional receiver, or converter, we can produce excellent steel for castings.

Some tests have been made of this new process, and the following are extracts from the test book.

Coke Consumption—Every ton of metal charge = 1½ cwt. coke.

Test on 2 1-inch bars . . . . . 36-inch centers

	Brake.	Deflection.
Pneumatic cupola	34.60	⅜
Ordinary cupola.	27	⅜

Sample tests from pneumatic cupola on pig iron costing $14.50 per ton:

Brake.	Deflection.
31.5	⅜
33.5	⅜
34.75	⅜
33.5	⅜

Tensile tests taken have been equally as satisfactory as the bending tests given.

By this process common pig, used for cast-iron pipes, can be so purified and improved as to remove all brittleness. The temperature of the molten metal is largely in excess of the ordinary cupola metal. The metal is more fluid, and thus lends itself to the casting of light ornamental work.

In one installation, where larger castings were required, arrangements were made for one receiver to two cupolas.

The exact pressure and quantity of air controls the whole operation, and to supply an excess or deficiency at various points of the process will render the whole method useless.

A consular report states that an expert commission pronounces the iron of the Sociedad Altos Hornos, of Corral, Chile, of a superior quality and suitable for general use in the navy, and for other purposes. These furnaces have a capacity of 200 tons per day, which will go far toward supplying the demand in Chile for that class of material.

New York Central Apprenticeship

By Fred H. Colvin

Four years' experience with a system which combines school and shop instruction in a very practical way.

Sons of employees given the preference and graduates have first chance at any shop on the system.

Full pay for graduates who complete the apprenticeship satisfactorily at any shop on the system.

Some of the advantages a large railroad has over a manufacturing plant in such a system.

The four years in which the apprenticeship system of the New York Central has been in operation, has taken it well beyond the experimental stage and enables us to see just what has been accomplished. It has been gradually extended until it now covers ten shops so it cannot be called a local institution or depend entirely on the personality of any one man, but can be considered as a system which has succeeded under varying conditions, not all of them favorable, and with boys of several nationalities.

Railroad shops have certain advantages over the average manufacturing plant in the opportunities presented for training boys in the shop itself without seriously curtailing the output. While in a large shop, as at Collinwood, many parts, such as piston rings, are made on a manufacturing basis, the great majority of work approaches the large jobbing shop which was ideal in many ways, for the training of apprentices. There are very few automatic machines used and the methods are well calculated to give a boy a good foundation in the principles of machine work.

Sons of Employees Preferred

Only boys between 17 and 21 years of age are accepted, preference being given to sons of employees. The boys must pass a medical examination which includes eyesight, color perception and hearing. Every boy must write out some kind of an application in his own words, every effort being made to make him feel at home and to overcome timidity. They must also have a knowledge of ordinary arithmetic, although the entrance examinations are made as easy as possible. Nearly all courses are for four years, the wage rate being advanced each year according to schedule. Time lost by the apprentice on his own account must be made up, but time lost by short time is not deducted. Sickness or injury in the service is considered according to the general standing of the boy and his time figured accordingly.

When an apprentice has completed his course he receives a certificate which is not only a recognition of his work but which gives him a preference to securing employment in any shop on the New York Central lines. They are encouraged to work in other shops in the system after graduating, to receive a wider and more varied experience.

Apprenticeship Course

The following is the regular course of apprenticeship for the several purposes, which should be adhered to as closely as possible and regular reports covering the subject made in accordance with notation on each report of any variation from this schedule and the reason therefor. Roundhouse experience shall be given apprentices in the machinist, boilermaker, blacksmith, tin and coppersmith and painter trades.

MACHINISTS.
Four-year Course.

Schedule.	
Helping in shop	0 to 3 months.
Bench work	6 to 12 months.
Light-tool work	3 to 6 months.
Heavy-tool work	3 to 12 months.
In one of either air-brake department, tool room or brass room	3 to 6 months.
Erecting shop	18 to 24 months.

This schedule allows 15 months above the minimum in the various departments, which can be decided between those on which the apprentice shows most adaptability.

BOILERMAKERS.
Four-year Course.

Schedule.	
Heating rivets, etc.	3 to 6 months.
Light sheet-iron work	12 to 15 months.
Flue work	3 to 6 months.
Riveting, chipping, calking and staybolt work	12 to 18 months.
Flanging and laying out	0 to 3 months.
General work	6 to 12 months.

This allows 12 months above the minimum in the various departments, which can be divided between those on which the apprentice shows most adaptability.

BLACKSMITHS.
Four-year Course.

Schedule.	
Hammer work and helping	3 to 12 months.
Light fire	12 to 24 months.
General work	12 to 24 months.
Heavy fire	3 to 12 months.

Fig. 1. Class Room at Depew, N. Y., Showing Models

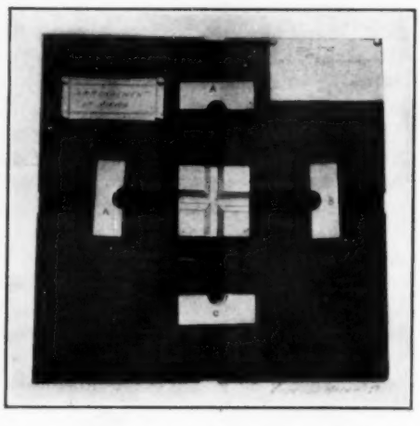


Fig. 2. Method of Showing Different Sides of Piece

NEW YORK CENTRAL LINES V-1
Shop Classes.

VALVE SETTING

Take the following measurements from the small slide valve engine in the classroom and fill in on this sheet leave this sheet with the instructor. Apprentices will work in groups of two. If engine is provided with link motion place name in full gear forward.

1- Diameter of Cylinder—carefully remove top cylinder head _____Inches.

2- Length of stroke-do not scratch the guides use chalk or pencil, or paste on a slip of paper _____Ins.

3- Diameter of piston rod_____Ins.

4- Length of crank, center to center—from center of crank pin to center of shaft = ½ of stroke_____Ins.

5- Length of connecting rod (main rod) center to center. Do not take out rod_____Ins.

6- Diameter of valve stem_____Ins.

7- Total valve travel—the distance that a point on the valve stem moves_____Ins.

8- Eccentricity, the distance from the center of eccentric to the center of the shaft = ½ valve travel_____Ins.

9- If an engine has a stroke of 28" what is the distance from the center of the crank pin to the center of the shaft?

10- An eccentric is set with its center 2" from the center of the shaft—What is the greatest movement of the valve?

NEW YORK CENTRAL LINES V-2
Shop Classes.

Place answers on standard sheet.

11- A locomotive has a stroke of 30" How far is the crank pin from the center of the main axle?

12- Does the thickness of piston have anything to do with the length of stroke? Give reason for answer.

13- Remove steam chest cover and take out valve. Make a sketch of the face of the valve which slides on the valve seat.

14- Make a sketch of the face of the valve seat. An impression of the valve seat may be taken by pressing a thick piece of brown paper against the seat.

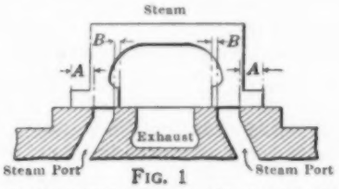
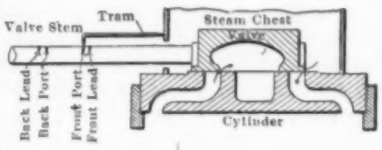


FIG. 1

SECTION OF SLIDE VALVE AND VALVE SEAT WITH VALVE IN MID POSITION.
A=Steam Lap *B*=Exhaust Lap

15- Make a scale drawing full size on a sheet of problem paper, showing the valve and seat in section with the valve placed in mid position at the center of its travel. Measure the steam and exhaust laps.

NEW YORK CENTRAL LINES V-11
Shop Classes.



NOTE: In order that valves may be adjusted on locomotives without removing the steam chest cover and also because the locomotive valve is arranged with the working surfaces hidden from sight, it is customary to place tram marks on the valve stem to show for both ends when the valve is at the edge of port and when open equal to the lead.

53- Set engine to run ahead. Obtain tram from instructor. Turn engine so that the lower edge of valve will be just at the edge of the lower steam port (either admission or cut off for the bottom of cylinder.) Then place the long point of tram against point on engine indicated by instructor. Chalk the valve stem and make a light scratch on it with the other end of tram. Instrs. O.K._____

54- Turn the engine until the upper edge of valve is exactly at the point of admission or of cut-off for the top of the cylinder and make a second tram mark on the valve stem. Instrs. O.K._____

NEW YORK CENTRAL LINES
General-Classroom Problems. ✠1031.

Name_____ Date_____

Fill in the space left blank in the table shown below by trying different weights placed on the model with stick, fulcrum and weights arranged for a 1st class lever as shown in fig. 1.

Note that *P* is one weight in pounds
W is other weight in pounds
A is one distance from fulcrum in inches
B is other " " " " "

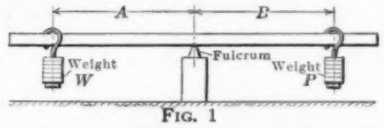


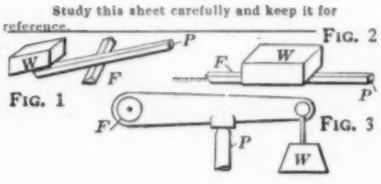
FIG. 1

	P	*B*	*A*	*W*
1		24	12	3
2	4	25	20	
3		16	24	4
4	3	24	18	
5	8	12		4
6	6		12	2
7		28	21	4
8	3	28	21	
9	5	9		3
10	6		30	1

NEW YORK CENTRAL LINES
General-Classroom Problems. ✠1029.

LEVERAGE.

Study this sheet carefully and keep it for reference.



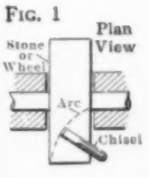
By lever is meant a bar of any shape either straight or bent which is free to turn about a fixed point called the fulcrum. A fulcrum may be any form of round bearing or stationary prop or support.

Levers are divided into three classes according to the relative positions of the fulcrum and the weights with which they are loaded. In the first class the fulcrum *F* (Fig. 1) is between the power *P* and the weight *W*. In the second class the weight is between the power, or force, and the fulcrum (Fig. 2.) In the third class the power or force is between the fulcrum and the weight (Fig. 3) In all three classes the rules or laws of the lever are the same.

FORCE and POWER mean the same thing. A force may be either a PUSH or a PULL. Power or force may be obtained in many ways such as by steam, air or water pressure or through a weight acting downward. In the case of a machine the force applied to it to set it in motion is called the power and the resistance to be overcome is called the weight.

NEW YORK CENTRAL LINES
Machinist-Home Problems. ✠ 401.

FIG. 1



When grinding a chisel always hold it at an angle on the stone as shown by Fig. 1, swinging it slowly in an arc of a circle. This prevents grinding a groove in the chisel edge if the stone is uneaven and not true. If the chisel were held straight in one place the edge would be just as uneaven as the face of the stone.

When chipping much stock always grasp the extreme end of the hammer handle and throw the hammer head back vertically over the shoulder with a wrist and elbow movement, bend the wrist freely with each blow. Do not hold the chisel too tightly as this will tighten the cords of the wrist and the jar of the hammer blow will make the wrist lame; another good reason is that if you miss the chisel and hit your hand it won't hurt so much. When chipping work in a vise always strike toward the dead or stationary jaw, this will not only make the cut easier but will save the vise from injury.

Any chisel may be easily softened and spoiled by over-heating when grinding it on the stone or emery wheel, the heat will quickly draw the temper. This is a common fault with beginners and if you have spoiled a chisel do not make matters worse by trying to use it. Get another and profit by your mistake.

It is possible to draw the temper of a chisel on an emery wheel even when there is a plentiful supply of water. When grinding the chisel draw it away from the wheel frequently in order to let it cool. When the head of a chisel becomes battered it should be redressed as small pieces of steel are apt to fly off and cut the hands.

American Machinist

TYPICAL PROBLEMS AND CLASS SHEETS FOR APPRENTICES

This leaves 18 months above the minimum in the various departments which can be divided between those on which apprentice shows most adaptability.

Other courses are: Molders, four-year course; patternmakers, three-year course; tin and coppersmith (locomotive department), three-year course; painters, four-year course; car builders, four-year course; planing mill, three-year course; cabinetmakers, four-year course; upholsterers, four-year course, and tinsmiths (car department), three-year course.

FOUR HOURS A WEEK IN SCHOOL

Each boy is assigned to a class which meets two mornings each week for a two-hour session. This is usually from 7:30 to 9:30, after which he goes to his work in the shop. This gives each boy four hours a week or about the same time as that given by the Cincinnati Continuation Plan.

The greater part of the two-hour session is taken up with drawing. This consists first of copying drawings, but very soon works into sketching and mak-

ing drawings. This is splendid exercise and whenever possible a boy is sent to sketch a broken piece and make a drawing for the blacksmith or patternmaker, as the case may be.

Arithmetic is taught by easy stages, using problems which come up in the shop. Lesson papers are prepared by a duplicating process and supplied to the different schools from the office of the superintendent of apprenticeship. Many of these are required to be done at home. Unless the minimum number of lesson sheets are answered, the boy may be required to lose time until they are completed or even dropped from the service.

In one case, where the shop is located a long ways from the city, it is arranged to let the delinquent boys make up their lessons in the school room during shop hours, losing pay for the time required.

FIG. 3. PROBLEM SHEET CUPBOARD

The instructor, however, is always ready and willing to explain away the difficult parts.

In one case the boy had become very delinquent and was ordered before the shop superintendent. The sentence was to go home and stay till he had caught up with his class. He appeared next morning with all his lesson sheet completed.

He had worked all night rather than be out a day.

While all the lessons are issued from the office of C. W. Cross, superintendent of apprentices, all possible latitude is given each instructor to develop in his own way. Suggestions are always welcomed and many of the good points have come from the various schools themselves, and their coöperation is earnestly asked and even urged at all times.

DRAWING FROM MODELS

The drawing is largely done from models, a collection of these being shown in Fig. 1, from the school room at Depew, N. Y. Fig. 2 shows the method devised by G. Kuch, the instructor at this point, to make clear to the boys just how the different views of a piece should be made and placed.

A core box is placed in the center and similar boxes are mounted on slides in each of the four grooves shown. These boxes are hinged to the slides and can be turned up as shown. Then *A*, *B*, *C* and *D* show the piece as it would look and as it should be drawn from each side. This would be more striking and more effective if the piece was not uniform, but presented different views from each side.

NO SUITABLE TEXTBOOKS

Realizing that textbooks which were suitable for apprentices were not obtainable, Mr. Cross and his assistants have prepared a large number of instruction sheets on paper 5½x8½ inches, which are supplied the boys, together with a suitable binder so that they may be easily preserved. These are printed by a mimeograph process. We reproduce a number of these which will give a good idea of the very practical way in which they are prepared and show how the questions are such as come up in everyday work and will appeal to any boy who is at all ambitious to learn.

In addition to the sheets of information, there are many sheets of problems, some of which are done in the class rooms while others must be worked out at home. These include machine-shop arithmetic, leverage, gearing, pulleys, incline planes, blacksmith work, types of boilers, riveted joints, stays, laying out sheets by triangulation, car building, bench work, molding, tinsmithing, painting, electrical work as applied to a railroad shop. Such locomotive accessories as steam gages receive very thorough treatment in a series of instruction sheets which make both the theory and the practice very clear to any apprentice.

Then there are drawing-lesson sheets, a number of these being general for all apprentices while the remainder are special according to the branch which the boy is taking up. Each branch receives careful attention, the car-building apprentice being thoroughly drilled in plain joints and other details of car works, while the machinist has details of locomotive parts as well as quite complicated assembly drawing, which makes extremely interesting work for any apprentice.

ENCOURAGING THE BOYS

The officials of the instruction department all realize that it is impossible to give a boy a complete mechanical education in the time allotted to this work, but even the dullest boy receives some benefit which makes him more valuable to the company and to himself, even if he has to be jogged along occasionally in order to complete his course.

What every boy is given to understand is that the instruction given in the class room is only the beginning if he has the proper inclination to pursue his studies.

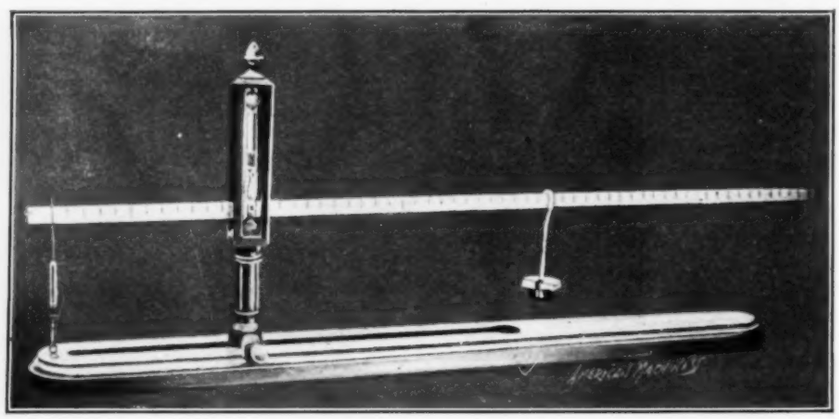


FIG. 4. LEVERAGE MODEL

These give him an inkling as to what lies before him and if he evinces any ambition to go further than is covered by the lessons, he is encouraged to do so and he is assisted in every way possible to learn all that he desires about railroading. The company fully realizes that boys of this kind will develop into the most valuable men in a few years, and they are very glad to encourage and assist in their development.

Every effort is made to interest the parent as well as the boys themselves, some instructors sending monthly reports of the boys' progress to their homes to be signed by the parent or guardian, and make it a point to get into personal touch with the parent as much as is possible.

Apprentices' clubs or associations are encouraged and assisted, and interesting talks provided for them when desired. These, however, are not by any means forced on them and the clubs are run entirely by the boys themselves so that they can feel that it is their own institution. In the Oswego shop, although

the number of apprentices is comparatively small, a very lively club organization has been effected and some very interesting speakers secured. The subjects are not confined to mechanics but include talks on travel, hygiene and the care of the body, and kindred subjects that are too often overlooked in the effort to be technical.

Full Pay to Graduates

Every apprentice of the old times remembers the difficulty in convincing the boss that he was worth journeyman's wages after he had concluded his apprenticeship. It was perhaps perfectly natural, that in the eyes of the boss he was still a boy. One of the developments of the apprenticeship system in the New York Central lines has been the doing away with this old idea and has resulted in retaining a large percentage of the boys in the company's shops. It is understood when an apprentice is hired that he will be discharged at the completion of his apprenticeship. If he has proved efficient, and it may generally be assumed that he has if he has remained during the completion of the entire term, he is reëmployed at the regular journeyman's rate for his particular trade. This seems to be an excellent plan from every point of view, for the boy who has served the full term of apprenticeship under instruction, both in the class room and in the shop, is certainly better adapted to the needs of that particular shop than the average man who would be hired. And the incentive of looking forward to the full journeyman rate on the completion of the apprenticeship satisfactorily, is having a good effect on the boys.

The officials advise in most cases, that after completing the apprenticeship the young man go to some of the other shops on the system so as to broaden his experience. Here he will receive the same wage rate as a journeyman hired into that shop and he can be transferred back to the home shop at almost any time he wishes.

The Shop Instructor

The school room forms but a small part of the instruction the apprentice receives. The shop instructor is always at hand and shows the boy just how to go about any new piece of work or how to best handle anything that comes along.

The instructor does not interfere with the foreman in any way but rather supplements him by taking the work of instruction entirely off his hands. It naturally took a little time to make some of the foremen see this but they soon found that it made their work easier and they now look upon the instructor as a valuable assistant. Discipline remains entirely in the hands of the foreman at all times. The foreman asks the instructor to start a certain boy on a certain job, or what boy will be best for the rod work or valve work as the case may be.

The instructor endeavors to show the boys how to run machines to the best advantage, tells them the reasons for doing work in certain ways.

There is no conflict, as each understands his duties and the results are good. It may be said that instruction is always good for boy or man as is being found out in many shops. The instructor devotes himself to finding the best ways of doing work and to imparting this to the boys, with a result that they often do surprisingly well in a few months.

Where to Start the Boy

There is a difference of opinion as to the best place to start a boy at work. The older idea was to let him begin by sweeping up and doing errands which have no good effect except to possibly obtain a certain familiarity with the work and shop conditions. Or, if the boy was exceptionally favored, he began by drilling holes.

Now it is a question whether to start a boy on some of the simpler machine tools or to let him help in the erecting gang for a few months, with many points in favor of the latter course. This gives him an intimate knowledge of the parts of a locomotive and of their relation to each other, which should be extremely valuable all through his training period.

Learning By Doing

He can learn the kind of fits necessary in the different parts of the locomotive; see the amount of play needed by the side-rod brasses; see that the frame bolts must be a drive fit and many other points which can only be obtained by actual contact with the work. And, knowing these things, he can use much better judgment when he comes to the point of making them in the course of his regular machine work. When we consider that good judgment is one of the most desirable assets any man can have, for there are times when all rules go askew, anything which tends to cultivate this quality should be carefully considered.

But, whether this is the best place to begin or not, circumstances prevent it being done in all cases, and the instructor and the foreman get together to find the best places for the boys as they come along.

The instructor relieves the foreman of a lot of worry about the boys and leaves him free to be the executive of his department, which is as it should be.

Advantages of a Railroad System

A large railroad system has a number of advantages in the training of apprentices over the manufacturing establishment. To begin with, every boy who is at all mechanically inclined is more or less taken with a locomotive and it affords endless opportunities for keeping the boy interested. Valve motions, steam gages, injectors, air brakes and other accessories, as well as problems involving the performance of the locomotive on various grades and curves, give excellent opportunity for talks, illustrated with lantern slides, and all sorts of problems in which he can readily see the direct application.

Furthermore, after he has completed his apprenticeship, he can go to perhaps a dozen shops on the same system, securing new experiences and becoming broader in every way without going outside the fold of the same company. They are receiving the benefits of the instruction given him no matter in what shop he may be employed, so long as it is on

Fig. 5. The Beech Grove Schoolroom

their own system, which removes an objection sometimes brought up by comparatively small manufacturers that they are training apprentices to work for their competitors a little later.

ENTHUSIASTIC INSTRUCTORS

In all of the schools visited the instructors seem to be thoroughly in love with their work and to have a personal interest in the success of all the boys. This cannot fail to have its good effect and be in a large measure responsible for the success which has attended its adoption.

Fig. 3 shows one of the cases arranged to hold problem and instruction sheets. Similar cupboards hold the drawing board and instruments when not in use. At the close of the lesson the boy places his T-square and instruments on his drawing board and forms in line to place them in their respective places in the cupboard shown. On his way he passes the instructor, who sees that everything is in place before the board is put away.

Both Figs. 3 and 5 are from the Beech Grove shop.

WORKING OUT PROBLEMS FROM MODELS

One of the interesting features is the use of working models of steam engines or valve gears to solve some of the problems which are presented in the lesson sheet. Leverage is worked out from actual models, as shown in Fig. 4; screw jacks and other applications are also shown in the same way. In their lesson on valve setting, for example, they have the sheet shown in Fig. 6, which has blank spaces to be filled out for the different dimensions, which they must accurately measure for themselves. In this way they learn to set valves by actually doing it, which means a great deal more to the average boy, or to anyone else for that matter, than any other kind of instruction. Valve motions of various kinds, such as the Walschaert and Stephenson and the regular links, are supplied to the class rooms and the actual effect of various cutoffs and valve adjustments can be readily seen and measured. Many of these models have been made by the apprentices themselves. In starting a boy on valve-setting work, all the adjustable parts are given an incorrect setting, the boy is given a set of instructions, a standard valve measurement sheet and allowed to work out his own salvation with the privilege, of course, of asking the instructor any question he may desire. This makes the work thoroughly practical in every way and the boy remembers it.

HOW THE BOYS MAKE GOOD

In the reports of instructors at the convention last year there were many instances given where apprentice boys at various stages were doing such work as making complete drawings for a compound-air pump; designing a new driving box; making elevation sketches and drawing for rebuilding a locomotive; being in charge of repairing pneumatic tools; laying out a locomotive frame for outside equalized brakes from a blueprint; taking charge of the valve-setting job during the absence of the regular man; laying out all patterns for thirteen new boilers and for new locomotive tanks and for other equally interesting performances which leave no doubt as to the instruction being thoroughly practical or that it is a paying investment for the railroad as well as for the apprentice.

Much of the success of the system has been due to the initiative and hearty coöperation of J. F. Deems, general superintendent of motive power, rolling stock and machinery, and his assistants, while C. W. Cross and Henry Gardner are to be commended on the manner in which the work is being carried on. Some of the work of preparing the earlier lessons of this course was done by Walter B. Russell, now director of the Franklin Union, Boston, Mass.

An Adjustable Indicating Caliper

By Peter J. Linnahan

An indicating caliper of handy design for both inside and outside measurements. A tool of wide application in many kinds of work requiring accurate results.

The illustrations herewith show an indicating caliper which I have invented and also some of its uses.

The tool can be used for both inside and outside measurements, shows a total variation of 0.030 inch and indicates accurately each thousandth from 0.001 to 0.030 inch. This tool has been used by the inspectors in the factory of the United Shoe Machinery Company, Beverly, Mass., for some time, with entire satisfaction.

Fig. 1 shows the indicating caliper with an adjusting arm that will enable the operator to adjust the points to any part of the scale that he wishes, making it read 5, 10, 15 or 20 after he has it tightened up, as the arm has a taper screw fitting in a slot that forces the point the way the operator desires. The arm being of spring temper it holds the screw taut in any position.

Fig. 2 shows a number of parts that can be measured accurately with this tool but cannot be measured with any other tool that I know of. The shaft shows how you can measure the length between shoulders and between bearings, you can also measure the exact depth of the recesses. This also shows a grooved pulley, segment, fork lever, disk, gear, bevel gear and lever with slot determining whether the slot is central or not. By using models you can find the difference, if any, very quickly.

Fig. 3 shows how it can be used for boring, setting it to zero with a micrometer or ring for the size of the hole. The

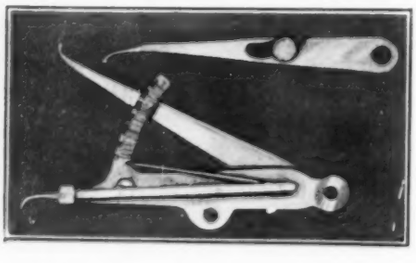


FIG. 1. AN INDICATING CALIPER

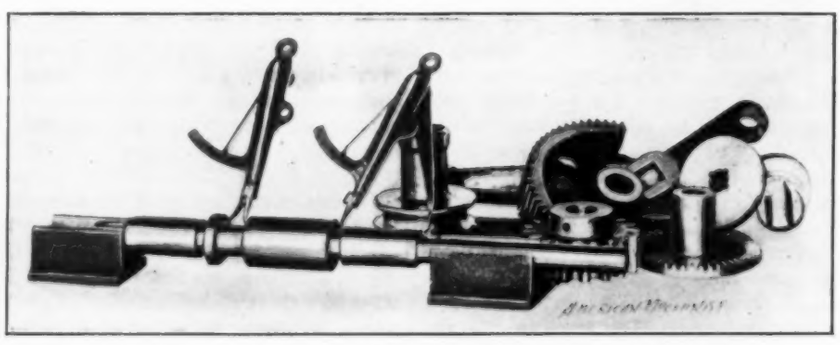


FIG. 2. MEASURING BETWEEN SHOULDERS

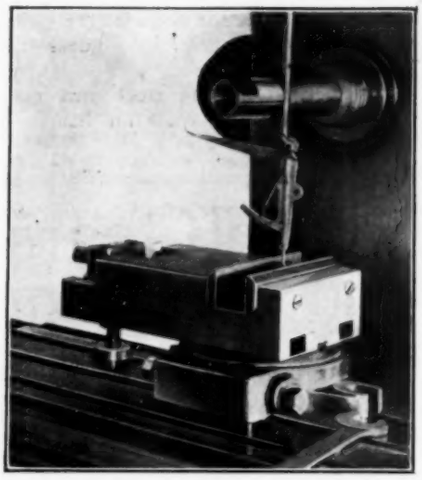


FIG. 4. SETTING A MILLING VISE SQUARE

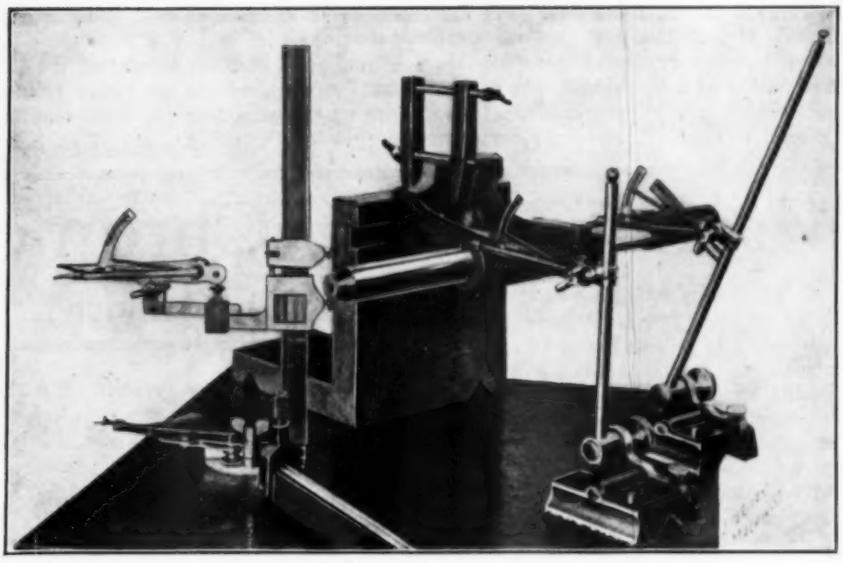


FIG. 5. TESTING ALINEMENT OF A HOLE

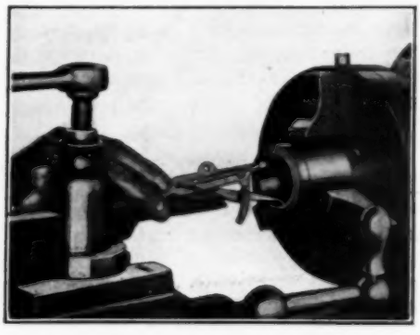


FIG. 3. DETERMINING THE SIZE OF A BORED HOLE

cut shows there is 0.015 inch more to be bored from the hole. In determining the size of any hole, over or under standard size, it will tell you just what the hole measures and it will enable the operator to make running or driving fits as he desires, very quickly.

Fig. 4 shows how it can be used for setting or testing vises or angle plates or any piece you wish to set square on a milling machine. You can also use it in setting your cutters central with any piece you wish to mill.

Fig. 5 shows it being used as a test indicator, showing the amount the hole is out of alinement in the piece being tested, one indicator finger pointing to zero and the other pointing to twelve showing 0.012 inch out of line. It is also shown mounted on a hight gage, enabling the operator to take a number of readings without changing the indicator, by moving the vernier up or down the gage. It also shows how it can be mounted for use in a lathe for testing purposes of all kinds.

It is almost a universal tool and can be used in a number of different ways.

Mechanics generally will be relieved to learn that radium is now a little cheaper. The value is now estimated at $2,100,000 an ounce, a reduction of $400,000 since the last quotation. It can be rented, however, for $200 per day for 0.015432 grain.

One Reason Why Steel Is Not Uniform

By R. E. Marks

A visit to a steel plant where the "head looker" determines the heat without instruments of any kind.

Why should not the makers of steel use pyrometers as well as those who use the steel?

Once in a while a fellow gets a jar that sort of loosens up his ideas and makes him wonder just where he is at. This is just what happened to a friend of mine, Jackson by name, who is holding down a good job as superintendent of a shop that makes barrels of small cutting tools.

They work up tons of steel every month, mostly high speed nowadays—but still using a lot of plain, raw carbon—and like most users that I know of, are having more or less trouble to get two batches of steel that will come out the same in the hardening room. This is especially true of their high-speed steels.

And this in spite of cyanide and lead baths, darkened rooms, pyrometers and all sorts of the latest devices.

So Jackson took a trip to the steel district to the mills where the steel he used was made and started in to get points that would help him in annealing, hardening and tempering.

Then he began to learn things in double quick time.

He watched the "head looker" at the steel mill go round and peer into the different furnaces, watched the steel being poured out into ingot molds and saw the separation into grades and as that mystery grew, he began to ask questions.

"What pyrometers do you use? Where are they? What heat is best for the high-speed steels?" and a dozen or so other perfectly natural questions.

And do you know—but I'll let Jackson tell it, he can put more flavor into it.

"There wasn't a pyrometer in the place. Didn't seem to be dead sure just what kind of an animal it was, but knew it didn't grow around there. Wouldn't have known one to meet it in the office.

"The head looker just squinted at the metal till it looked about the right color and then he pronounced it O. K. His look was law, and all the pyrometers in the whole United States of America wouldn't change his say so. He knew when it was right and that was all there was to it.

"Now, I don't believe there's a pair of eyes made that can tell within fifty degrees when it comes to red- or white-hot steel. Eyesight is dead sure to be affected by the looker's disposition, which in turn depends on his digestion. And I'll bet we seldom get steel that has had very near the same heat treatment from start to finish before it comes to us.

"So it seems we're expecting altogether too much of our elaborate heat-treating outfits. The best cook in the world can't

make good bread if the flour isn't first class and that's the way with our steel. We get whatever 'looks good' to the head peeker of the steel mill, who doesn't know within a wide margin at what heat the steel was melted. All our pyrometers and other things that cost good money seem to be useless.

"And yet I wouldn't go back to the old way for we know we get better results than we did without them, which may be because we cut out one set of guesses. One man is more apt to guess the same way than two or three, so I guess it's better as it is.

"But why can't the steel men quit guessing and really *know* the heats as well as we can?"

Machining Large Chrome Nickel Gears

By C. L. Goodrich*

An equipment especially adapted for turning large bevel gears of chrome-nickel steel.

One setting allows for turning three bevel faces, and finishing a flat face, simultaneously.

*Department foreman, Pratt & Whitney Company.

An equipment which shows the adaptability of the Pratt & Whitney 2½x26-inch turntable lathe, is shown in the accompanying illustrations. It is particularly utilized for turning large bevel gears of chrome-nickel steel up to 12 inches outside diameter, such as are found in the differential-gear box of automobiles. Tools are arranged for simultaneously turning three bevel faces, and in addition a flat face is finished at the same setting.

The gear blank, which is previously bored, is held truly and rigidly on an expansion arbor consisting of a body carrying three rectangular jaws, all of which are expanded by means of a central sleeve with tapered slots. Movement of the sleeve is obtained by an operating screw, and adjustment is provided to insure the permanent truth of the arbor.

The angular tooth face of the gear is machined by ordinary lathe-cutting tools held in the tool block on the cross slide of the machine. The cross slide is mounted on a subbase and may be adjusted and operated at any angle up to 45 degrees.

The top and bottom angular sides of the teeth are machined by single-point cutting tools held in special taper-turning fixtures (roughing and finishing) mounted on the turret, as shown. Each of the taper-turning tools has a body and slide, the body being rigidly secured to the turret by bolts. Movement of the slide is controlled by a taper bar having the desired angle. Attention is called to the rigidity of the overhead-supporting bar and bracket which permit of heavy cuts being successfully taken.

Flat facing is accomplished by a single-point lathe-type tool mounted in a tool block on the turret, which, on this lathe, has power cross feed. The turret slide and swivel cross slide also have power feed. All of the power-feed functions may be operated independently or simultaneously, and have adjustable automatic knock-off devices. Gear blanks, as shown by Fig. 2, are machined in approximately thirteen minutes on the faces indicated. This time, of course, is dependent somewhat on the amount of stock left to remove and also on the hardness of the blank. High-cutting speeds are possible, due to the excellent lubricating methods.

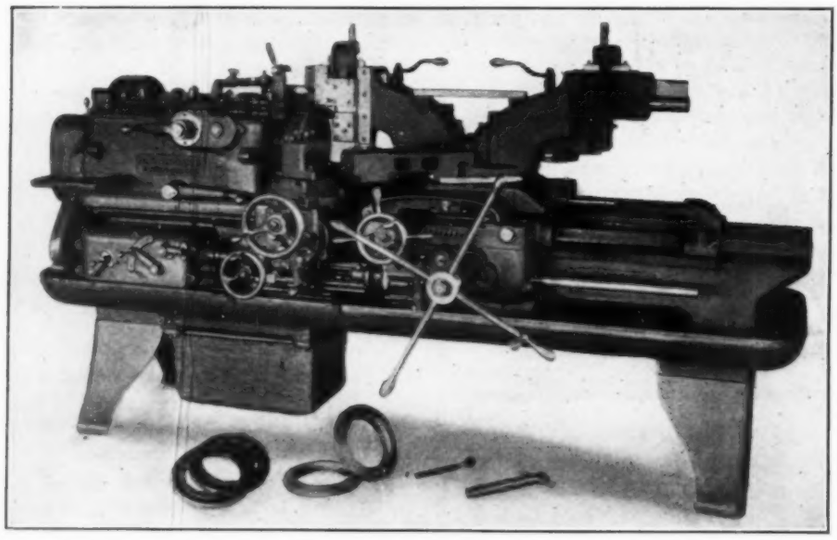


FIG. 1. MACHINING LARGE CHROME NICKEL-STEEL BEVEL GEARS

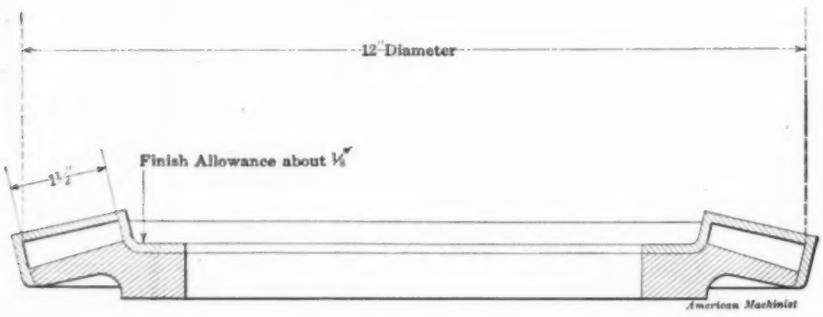


FIG. 2. THE WORK

Colored Lacquer

The finer qualities of lacquer are prepared by exposing the better grades of raw varnish, in shallow wooden pans, to the action of the sun or gently heating and stirring them over a fire. This causes the varnish to become dark brown in color and of the consistency of syrup. The product thus obtained is used for finishing, over coats of colored lacquer. For colored lacquers addition of pigments is made during the stirring and exposure to the sun.

The best black lacquer is obtained by the introduction of an iron salt. Cheaper black lacquers consist of an inferior grade of raw lacquer mixed with the drying oil from perilla seeds. The so called "pear ground" lacquer, which is used with gold dust, is obtained by the addition of gamboge, while an inferior one is prepared by the addition of perilla oil, plum juice or the yellow extract of the fruit of *Gardenia florida.—Brass World.*

A New System of Limit Gages

By William Taylor*

The working gage is capable of adjustment through a wide range of sizes, the tolerance only being ground into it. Errors of construction and those due to wear of the gages are controlled by a secondary series of limits.

*Governing director, Taylor, Taylor & Hobson, Ltd., Leicester, England.

The high initial cost of gages of the fixed or snap type, together with the fact that they cannot be satisfactorily corrected, but must be discarded after a limited amount of wear, sets the most serious limitations on their use. Of the soundness of the limit-gage system all advanced constructors are convinced, but the cost of a complete set of fixed gages for any work except that done in large quantities makes their adoption for large classes of work, for which they are perfectly suited, economically impossible.

The object of this article is to illustrate and describe a system of gages, which is in large use in the works with which I am connected, and which has proved itself extremely satisfactory. In it the initial cost si reduced by the fact that each gage serves for a wide range of sizes, while the fact that correction after wear is entirely feasible gives each gage an unlimited life. Growing out of this feasibility of correction is a system of limits to the wear of the gages themselves, which is believed to be peculiar to these works, and which has done much to introduce absolute system into our gaging department.

Limits for the Gages as well as for the Work

With any system of fixed gages the time sooner or later arrives when the wear, more especially of the go gage, must be considered. Whether or not the wear has exceeded permissible limits is usually left to the judgment of an individual, whereas under our system the extent of this wear is given a defined limit. Thus with a total limit in the product of 0.001 inch, we commonly provide a limit of 0.0002 inch for the gage, which is sent to the tool room at regular periods for examination and is corrected whenever it is found to have become worn below a predetermined limit, and in correcting it, it is merely brought once again between certain limits of size, which thus cover both errors of construction and errors of wear of the gage and effect obvious economies.

Description of the Gage

The gage is shown in Fig. 1, the gaging distance for turned work being that between the jaws and parallel with the bar; the gaging faces of the jaws are truly radial with the bar. The faces of the two jaws of one of the sliding heads occupy the same radial plane, while of the other pair the working ends are stepped back from this plane by the amount of the limit—in most cases 0.001 inch. In the foreground is a rod gage ground to the go dimension, and at the left is a key for clamping the heads to the bar.

When adjusting a gage to any size within its capacity, it is placed upon a suitably shaped bed, Fig. 2, having a provision for receiving the rod gage, which will be recognized in the illustration by the figures giving its size, and the heads are then adjusted to contact with the rod, all as shown.

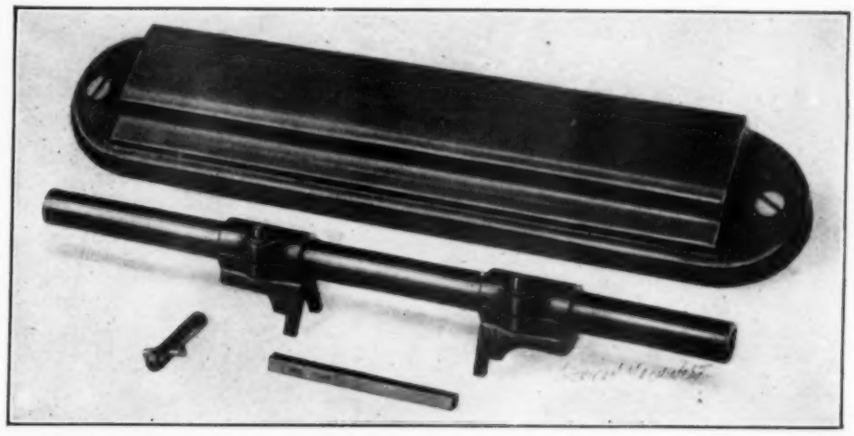


Fig. 1. The Working and Setting Gages

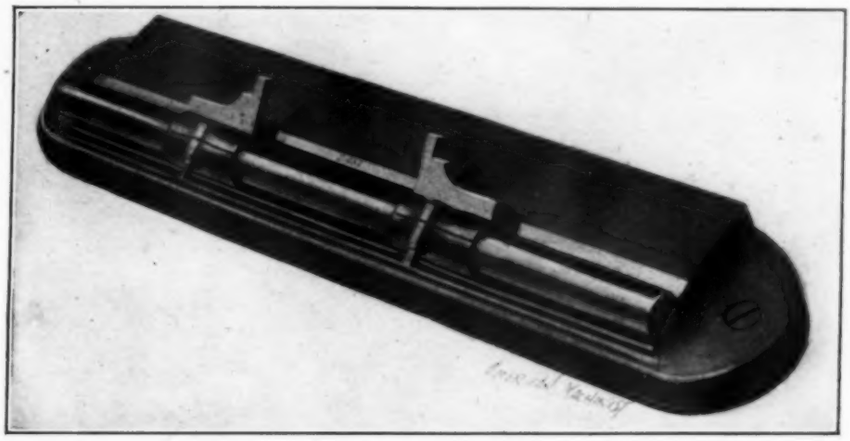


Fig. 2. Adjusting the Working Gage

Work for Which the Gages Are Used

The leading use of these gages is in the chuck-lathe work connected with the manufacture of the threaded metal parts of photographic lenses and other optical instruments. The work involving both turned and bored work, the gage must be suited to the latter as well as the former, and for the latter the outside sides of the gage legs are adapted by suitably rounding them. The inside faces of the gage legs thus gage the outer or full diameter of the male pieces, while the outer faces gage the core diameter of the female pieces. Different gage rods are, of course, required for the two.

In limiting the amount of wear of the gages we must, of course, consider both the wear of the rod gage, which alters the base size of the work, and the wear of the gaging jaws, which alters the prescribed limits only. The wear of the rod gage is, of course, much the less in amount, although fundamentally the more important.

Inspecting the Rod Gages

Fig. 3 shows a section of our table of limits for a number of rod gages, which is produced from a blueprint table supplied to the gage department, to which all gages are sent for inspection at stated intervals.

Plant No.	Normal Screw Diameters. F = Full. C = Core.	LENGTH SHOULD BE		Length Is	Alterations Made.
		Not Over	Not Under		
134	F 1.063"	1.0631"	1.0629"		
	C 1.020"	0.7201"	0.7199"		
135	F 1.398"	1.3981"	1.3979"		
	C 1.355"	1.0551"	1.0549"		
136	F 1.713"	1.7131"	1.7129"		
	C 1.670"	1.3701"	1.3699"		
137	F 1.987"	1.9871"	1.9869"		
	C 1.944"	1.6441"	1.6439"		

FIG. 3. TABLE OF LIMITS OF WEAR FOR ROD GAGES.

Plant No.	The sum of separate measures of the two jaws "F" to be Not over 0.3002" Not under 0.2998" Is now:	When assembled and sliders together these jaws "F" to be Not over 0.3012" Not under 0.3008" Is now:	The other jaws, unmarked, when assembled and in contact to be Not over 0.3022" Not under 0.3018" Is now:
131			
753			
861			

FIG. 4. TABLE OF LIMITS FOR WORKING GAGES.

Taking No. 134 as an example, the two dimensions in the second column opposite the letters *F* and *C* show the normal diameters of the turned and bored pieces respectively, while the dimensions in the second and third columns opposite *F* show the upper and lower limits of the rod gage for the turned piece—the tolerance being 0.0002 inch. Similarly, the dimensions opposite *C* show the same things for the rod gage for the bored piece, the dimensions shown being less than that of the work by the combined thicknesses of the two jaws of the working gage. The fifth column, which is blank, provides a place for recording the results of the inspection, and the last column for recording the amount and date of any alteration.

INSPECTING THE WORKING GAGES

When inspecting the working gages we are, of course, concerned with the correctness of the limits only, and for this inspection of the blueprint blank in Fig. 4 is provided. In order to make use of outside micrometers for testing the insides of the jaws an indirect procedure is necessary. Beginning with the middle broad column of the blank, in the caption of which "jaws *F*" refer to the upper limit jaws, it is obvious that if the jaws *F* measure within the limits given at the head of the column, these jaws are within the limits laid down for use as a boring gage, while if the lower limit jaws, referred to in the heading of the third column as the "unmarked jaw," measure within the limits there given, the lower limit jaws are correct for the same use.

The boring sides of the jaws being thus determined, the turning sides are then inspected by measuring the actual thickness of the two jaws and adding the results together as indicated in the first column.

A Portable Railroad Shop

By Wm. A. Saxton*

In order to have a shop that could keep pace with the construction work of the railroad without the delay of waiting for a locomotive, we have equipped a car, as shown in the accompanying illustration. This we find much more convenient than having a small portable shop, which has to be moved as fast as we progress in the construction work.

The shop is built up from a flat car which is 40 feet long, 10 feet 4 inches wide and 10 feet high, outside. At the far end of the car is a Fairbanks-Morse vertical gasolene engine, and in front of it a closed casing which contains the gearing and chains for propelling the car to any desired point on the line or on a side track.

The machines are: A 16-inch shaper, a double grinder, a vertical drill, a 1-inch bolt cutter, a 6-inch pipe machine and a 14-inch lathe, raised to swing 24 inches. Work benches and vises are conveniently arranged and well lighted. There are also cupboards for small tools.

We find this very convenient for any repair or construction work that comes within its range, and has proved all that we anticipated.

*Master mechanic, North Coast Railroad Company.

A PORTABLE RAILROAD SHOP

Heating cast iron to a dull red and allowing it to cool, the operation being repeated 30 to 40 times, makes cast iron quite porous. As an illustration, it is stated that cast-iron plates, so treated, after being planed on both sides to a ¼-inch thickness, will absorb a few drops of oil placed on the top, which will pass through the iron to the bottom of the plate in less than 5 minutes.

Another View of a Professor's Work

By Thermodynamics

Why many professors prefer to teach at a low salary instead of earning more in commercial work.

My friend Entropy has been "spilin' fer a lickin'" for some little time. Like the small boy at the circus, he has been throwing pebbles into the cages to see what he could do in the way of stirring up the animals (at so much per stir). His description of his work as a teacher moves me to reply.

Entropy has been wanting to know why, if professors can attempt to train young men for $5000 positions, they do not go out and get such positions themselves. The reasons are various as will appear from what follows.

Experience with Commercial Work

I am a young man, thirty years of age, and professor of mechanical engineering of one of our State colleges. I graduated from our leading engineering school nine years ago, and have since then spent four years in pursuit of my profession with various manufacturing companies and five years as a teacher. During the four years that I was engaged in commercial work, my wages increased from $65 a month to 50 cents an hour, or practically from $780 to about $1100 per year. Having arrived at the $1100 per year position, I knew that the chances were very good for staying there indefinitely, since I had no influential friends connected with the company. For two years I watched young men with inferior education, and in my opinion inferior ability, take the places I desired to have, because their uncles and grandfathers were stockholders and directors in the concern. I know I am right in stating that I would have remained to this day in the same position, receiving the same pay, for a friend of mine of practically identical education and of very considerable ability in his profession, is still receiving 52 cents an hour. This is an advance of 2 cents an hour in the course of five years.

Concluding that while my usefulness to the company might be very great, their usefulness to me had ceased to exist, I endeavored to obtain another position. I had been employed in the design of large engines. My training and ability fitted me to take up the design of any kind of heavy machinery. No one, however, except those concerns which were engaged manufacturing an identical line, would consider my application at the salary which I demanded, namely; $1000 a year or more. There did not seem to be any opening in my line of work, and receiving an offer of $1000 per year as teacher of machine design in a prominent university, I accepted the position.

Experience with Teaching

In teaching I found that my progress did not depend on the amount of stock which my uncle owned, but rather upon the amount of brains I possessed. Starting as an instructor, at the end of the year I was made an associate professor, with an increase of salary. At the end of the second year I was made a full professor with a larger increase of salary, and at the end of the third year, I accepted my present position as head of a department at $2000 per year. I have been two years in my present position without an increase of salary, for the reason that this is the largest salary which the institute is able to pay for this grade of work. I shall probably find a better position in the course of a few years, and expect eventually to receive $5000 a year, if I stick to teaching 15 years longer.

In reviewing my experiences in commerical work, and in teaching I am contrained to believe that a man of ability without a pull, may advance a great deal faster as a teacher than he could in commercial lines. This seems to me to be ample justification for my course in becoming a teacher.

Teaching More Attractive

While I am successful as a teacher and enjoy the work very much, I am perfectly willing to go back to commercial work at any time I can get $4000 a year for my services. I am willing to change to another institute for $3000 a year, so you see that I consider teaching at least 33 per cent. more desirable as an occupation, than commercial work, and the reasons are as follows:

In the first place, the work which I do as a teacher is intensely attractive to me. I like to associate with young men. I enjoy getting their viewpoints of life. I like their fresh and virile personality. I enjoy the process of imparting instruction to them. It is very great pleasure to me to watch their development under that instruction; and I like to study them in the process of gaining an engineering education. The whole thing is fascinating. Very little commercial work has anywhere near the same degree of fascination.

In the next place, I have a very considerable degree of control over my time. I have a long vacation in the summer, and while I have to do a very great deal of work during this vacation, I can do it when and where I choose. While I am obliged to do quite as much work per week during the school year as nine men out of ten, I can do a considerable part of this work at such times as I choose, which is a very great advantage to any man who enjoys being with his family and looking after their comfort and pleasure.

Breadth of a Teacher's Work

In the third place, the line of work which I do here involves the teaching of many engineering subjects and is much broader than that which I would do in any commercial plant. I am constantly in touch with all phases of my profession, and therefore I am constantly improving as an engineer. We all know that it would be very different if I were connected, for instance, with a radiator company, and concerned only with the production of the hollow castings. The difference in the outlook upon my profession is the difference in the outlook of the dweller in the valley and the dweller on the mountain. That is worth something to me.

Now, I realize thoroughly that I am a "nonproducer;" that my time and efforts are not spent in the moving of materials, which is the sum and substance of the real work of the world. This does not mean that my services are valueless to society, for if I were engaged in commercial work, I would still be a nonproducer for my time and effort would be spent in the direction of the producers. My services are just as essential to the welfare of the world are those of the manager or superintendent of a factory, because without me and my work, the factories of tomorrow would be less efficiently managed and operated. Salary, in its essence, is a reward for social service, and the amount of reward is very seldom proportional to the value of the service. Instead, a salary is usually proportional to those opportunities offered by our complex and artificial business and social system, which enable us to exact from others more than our rightful share of the wealth of the community. As an example of salaries obtained under such conditions, I may mention the salaries drawn by some of the officers of our large insurance companies, previous to the Hughes investigation; the annual retainers drawn by prominent corporation attorneys for not working for other people; and the fees drawn by dummy bank directors, for not doing their duty, in the case of banks conducted in a manner contrary to our banking laws. My services, like those of most men, are worth more than the salary which I receive for

them, and I get this salary not because I can get $3000 or $4000 a year in commercial work, if I choose to do that work, but because the services which I render are worth the salary which I receive.

Doubts about Entropy's Identity

In reading over Entropy's article, I am moved to inquire if he is really a teacher at all. If he is, it is a wonder to me that he holds his position. I can conceive of a man bluffing the president, because I know some that do, but I cannot conceive of a man who bluffs the boys. I never could, I always knew I never could, and I never tried to. I never asked a man to learn anything that I did not absolutely believe, although I can remember two occasions upon which I was mistaken, and had to apologize to a class for teaching them as true things which I afterward found out were not true. I have never yet padded out a course, nor has any man who has honestly attempted to teach.

Entropy a Poor Teacher

I think one trouble is that Entropy misses the whole purpose of a technical education. He says he lectures upon things that he knows "the boys do not, once in a thousand chances, ever have occasion to use." His statement marks him as a poor teacher. He attempts to teach his students, as facts, the things which they will have no occasion to use. I teach my students principles, not facts, and then perfect them in the application of these principles in practical work. The principles upon which the structure of engineering science rests are few in number and easily apprehended. The application of these principles to the practice of engineering requires common sense, logic, breadth of vision, originality, genius if you please. An engineering education involves not alone the learning of scientific principles and engineering facts, but the training of all the mental faculties of the student in their right application. In teaching the student to gather together the principles which he has learned or is learning; to apprehend their interrelation, and their combined application to a given problem, I am training him in correct methods of engineering thoughts, and giving him a certain habit of mind. If he ever has occasion to design a flying machine, I shall expect him to take the principles which I have taught him in Materials, in Hydraulics, in Mechanics, and in Thermodynamics, and to apply these principles to the construction of the machine in exactly the same way as I would expect him to apply them, or similar ones, to the construction of a pump or a boat. I attempt to develop the man's faculties, not to store his mind with facts.

A Teacher's Hours

As to the time required in teaching, Entropy says he teaches 18 hours a week and leaves us to infer that altogether he works about 24 hours a week. I expect this year to conduct 14 recitations and laboratory exercises each week. If past experience gives any clue to the amount of actual time this will take, I expect to do about 50 hours of work a week. To be sure, I will not throw the examination papers in the waste-paper basket without correcting them. I did so one year with some examinations, when the total amount of work required of me each week was 85 hours. I do expect to revise my courses each year and to improve them and strengthen them, in every possible way. If I do not, I would consider myself a fossil. I do not do this because I have learned new truths in engineering and mathematics since last year, but because I wish to make my work more readily apprehended by my students, more interesting to them, and more useful in my purpose of stimulating their mental development. In other words, my experience in teaching and my careful perusal of my examination papers have taught me something in psychology. If Entropy had carefully reviewed his examination papers instead of throwing them in the waste-paper basket, he would have discovered ere this what a bum teacher he is, and changed his views of education and methods of instruction.

Favoritism in the Commercial World

There may be something lacking in a professor who does not go out and get a four thousand-dollar job. I know a good many men in the teaching profession who receive poor pay because they are poor sticks. They would receive just as much, or more, in the commercial world, because they would soon find a place where their lack of personality, or ability along certain lines, would not make itself felt to their detriment. They have no business as teachers. They do not and cannot advance. I have helped some of them to other positions when they finally realized their limitations. On the other hand, there are a great many men engaged in teaching, not because they are lazy or because they are incapable, but for two very good reasons. The first is that the vast majority of the good positions in the commercial world are distributed by favor or accident, and the salary which a man gets, seven times out of ten is no criterion of his ability, or his potential value to his employer. This is true, because the average employer has absolutely no knowledge of the real abilities of 95 per cent. of his employees, outside of the line in which they are immediately engaged, and he never makes any attempt to discover them. The second reason is that there are many compensations in the life of a teacher, which often more than make up for the smaller salary which he receives. Perhaps one thing which attracts men of ability as much as anything else, to the teaching profession, is the fact that in this profession they are their "own bosses." They do not have to take orders from anyone. They know what they are expected to do and they do it absolutely in their own way. Their positions are permanent, financial stringencies, strikes, commercial failures, and so on, do not bother them; their work is interesting and inspiring, and while they have to work hard, they can daily see the results of their work, and know that it is appreciated by those for whom it is done.

[We hope our other readers did not take Entropy's "confession" so seriously. We did not. No sensible man does other than respect the teacher's calling and the true teacher, which our present correspondent obviously is.—Ed.]

Turning a Large Shaft on a Small Lathe

By Warren S. Sherman

Some days ago we received a telephone call from one of our customers stating that he had a crank shaft 12 inches in diameter, 12 feet long, a disk on it 6 feet in diameter and the whole shaft weighing about 10,000 pounds, and asking if we could turn the journals.

Our largest lathe would only swing 36 inches. My first thought was to raise the lathe. I then thought of doing the job in the following manner: We moved the head down on the ways far enough to allow the disk to overhang the end of the lathe and dug a hole in the ground for the disk to turn in. I was afraid the steady rest jaws would collapse under the weight so I got the shaft set central on a block of wood, took out the jaws of the steady rest and babbitted it up on the shaft solid on the bottom, making a bearing for the shaft to run in. When we came to run the carriage down to the extreme end of the cut we found that we would have to take off the box that holds up the lead screw to get to it. Next we had to devise some means of driving the lathe. This was done by a temporary shaft between two posts. The feed we rigged up by using a feed gear as a pulley on the lead screw and a 2-inch pulley on the line shaft to drive it.

With the machine rigged in this manner we did the job very quickly and with entire satisfaction to our customer.

Concrete floors were tried in a number of wooden vessels carrying ore and coal on the Great Lakes as a substitute for wooden floors, which suffer severely from the clam-shell buckets. The concrete floors are said to stand the wear very well.

Making Pneumatic Tube Sections

By F. A. Stanley

Methods of boring, milling, drilling and grinding cast-iron pipe sections of various shapes requiring some unusual tools and operations.

Special fixtures used for locating and holding the work while the flanges are milled at an angle, the interior ground out on an arc, the flanges drilled for bolts and dowel pins.

Details of the equipment used, including machine tools, holding fixtures and cutting tools.

Among the many special operations to be seen at the shops of the Blanchard Machine Company, Cambridge, Mass., there are quite a number, of considerable interest, in the machining of various cast-iron sections which form important members of underground pipe lines for pneumatic postal service. Some of the more important of these operations are illustrated by the accompanying engravings.

Character of the Work

The sections referred to are bends, reducers and closures, typical examples of which are illustrated in Fig. 1, where *A*, *B* and *C* are bend sections of 22½ degrees, 7 degrees 10 minutes and 5 degrees included angle, respectively; *D* and *E* tangent reducers with spigot and bell ends; and *F*, *G* and *H* closure sections. Details of several of these members are shown in the line engraving Fig. 2.

The latter engraving also includes another length of bend not illustrated in the halftone this being 11 degrees 15 minutes included angle. These different bends allow curves of various lengths of arc to be included in the pipe line wherever necessary and the reducers are attached to the bends to connect with the straight or main portion of the pipe line. The closure sections, *F*, *G* and *H* are located in man-holes either horizontally or vertically and the central members owing to the angular flanges may be readily removed for purposes of inspection or repairs at any time and as easily replaced.

A Few Dimensions

The interior of the pipe line is 8⅛ inches diameter and the steel carrier which is forced through it by compressed air in transmitting mail from one section of the city to another is 7 inches diameter inside and about 24 inches long. At each end of the carrier is a vulcanized rubber ring or gasket whose outer diameter is 8⅛ inches to correspond to the inside of the pipe. It is obvious that to permit a carrier of this length to pass around the curve in the pipe constructed to a radius of only 8 feet, as shown in the sectional view, Fig. 2, the passageway in the bends must be somewhat larger than the interior of the straight pipe section. From the figures upon the drawing it will be seen that the curved sections have a hole 8⅜ inches in diameter and the reducers are made as represented in the drawing, with a taper hole 8⅜ inches diameter at one end, 8⅛ inches diameter at the other. This taper hole, however, is not bored at right angles to the flange on the casting as might be supposed, but instead is so machined as to bring one side of the hole at right angles to the flange while the taper shows entirely upon the opposite side as indicated by the note up on the assembled section *D*, Fig. 2. The object of this is to bring the outer surface of the tangential to the outer line of the curved hole in the bend in order that the long steel carrier shall shoot smoothly around the corner which it would not do if the "high" side of the sections joined at this point were not provided with surfaces tangential one to the other.

Operations on the Bends

Figs. 2 to 7 inclusive show a few operations in machining the bend sections. The bends in these views are 22½ degrees included angle and approximately 3 feet in length the exact figure being given on the drawing Fig. 2. In making these castings in the foundry the inside diameter is formed quite accurately by cores made in finished iron boxes and it is calculated that with a moderate amount of grinding inside the hole shall be within the limit desired; the leeway in the diameter of the hole being 1/64 inch.

Setting the Casting in the Milling Fixture

The first machining operation on the bend sections consists in milling the ends of the two flanges to the required angle and boring out the mouth at each end for a short distance, this internal chamfering or bell mouthing enlarging the end of the hole to about 8 7/16 inches. Both milling and boring operations are accomplished with the fixture shown in Figs. 3 and 4.

In Fig. 3, fixture *I* is seen resting upon an iron bench *J* which is itself a fixture for facilitating the setting of the casting in the milling fixture. The milling fixture proper is located upon the platen of the milling machine by tongues on the under side which when placed in one of the

Fig. 1. Bends, Reducers, and Closure Sections for Pneumatic Mail Tubes

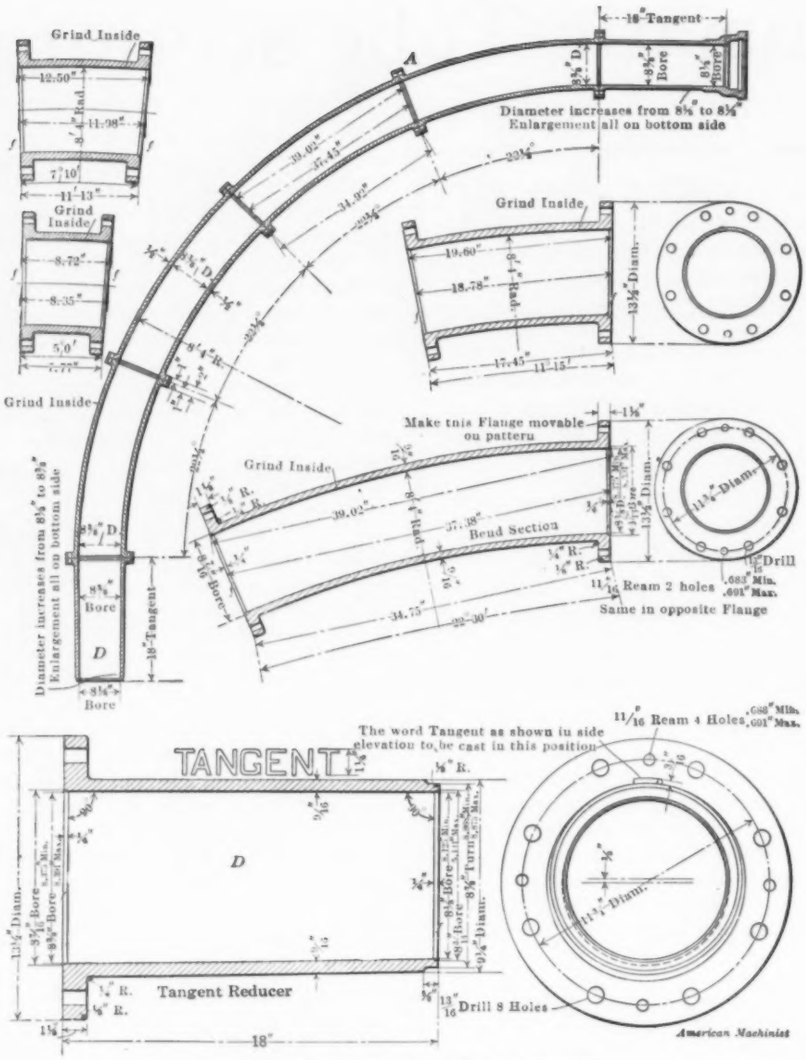


FIG. 2. PNEUMATIC MAIL TUBE SECTIONS

slots in the table set the work at the exact angle for milling off the face. Similarly the milling fixture is located upon the setting plate, Fig. 3, and the various gages shown enable the curved casting to be quickly located in position for machining.

HOW THE SETTING GAGES ARE USED

There are two of the milling fixtures and while one is in use on the table of the milling machine a rough casting is being set in the other. The templet *K* is passed through the hole in the casting, slipped over dowel pins in the uprights at either end of table *J* and a feeler is then used at each end of the curved templet between the templet and the inside of the rough casting and the casting adjusted until the feeler indicates that the curved hole coincides in position with the templet. Gages shown at *L* and *M* are also used in locating the casting in the fixture. These gages are placed upon locating spots at either end of the fixture and their curved points brought inside the casting. The adjusting screws under the fixture are turned as required to set the casting up or down at either end, or move it toward the back or the front. When properly located in accordance with the gages it is securely fastened by the straps over the top and the fixture is then ready to be placed upon the milling-machine table, as shown in Fig. 4.

MILLING AND BORING

The milling operation in Fig. 4 is shown so clearly as to require little explanation. As previously stated, the fixture locates the work immediately at the proper angle for the facing of the flange and when turned end for end sets the opposite end of the work at once to the correct angle. The cutter is 18 inches in diameter, with high-speed steel inserted blades, and is passed once across the work and back again.

After one end is milled and before the fixture is reversed, a special boring tool *N*, for chamfering out the mouth of the hole, is inserted in a recess in the cutter head, as shown clearly in the photograph. This boring tool has a quick-acting clamping device by which it is attached to its seat in a moment and the table is then operated to move the fixture against a swing stop shown at *O*. This stop, it will be noticed, when swung down comes in line with the gaging surface *P* at the side of the fixture, and it locates the work correctly for the tapering of the mouth of the hole in the casting. A similar gage at the other side of the column acts against the locating surface at the other end of the jig when the fixture is reversed for the milling of the second flange and the boring out of that end of the cored hole.

A HANDY DRILLING JIG

Following the machining of the ends of the bend sections, the casting is ready to have the flanges drilled for eight ¾-inch bolts and for two 11/16-inch dowel pins, which serve to line the sections correctly with each other. The two dowel holes are, of course, drilled a little under size to allow for reaming.

For drilling the flanges two jig plates are attached to the casting as in Fig. 5.

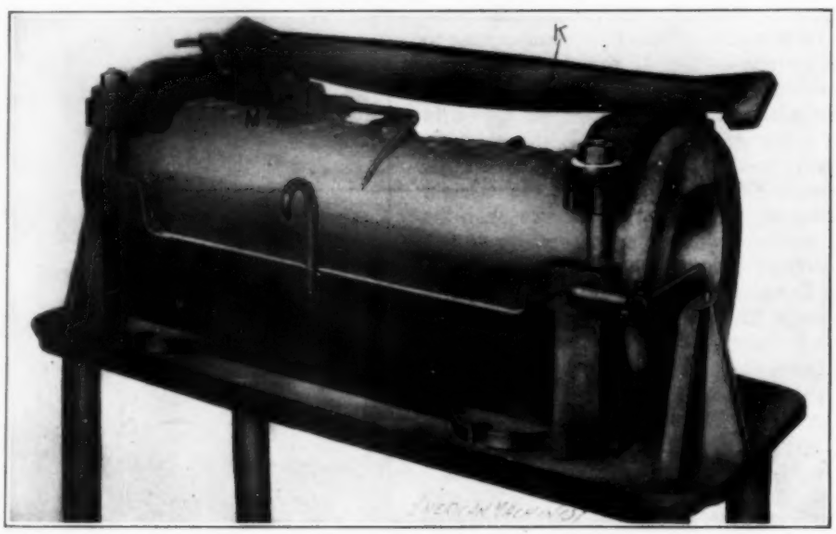


FIG. 3. A MILLING FIXTURE AND LOCATING PENCIL FOR THE WORK

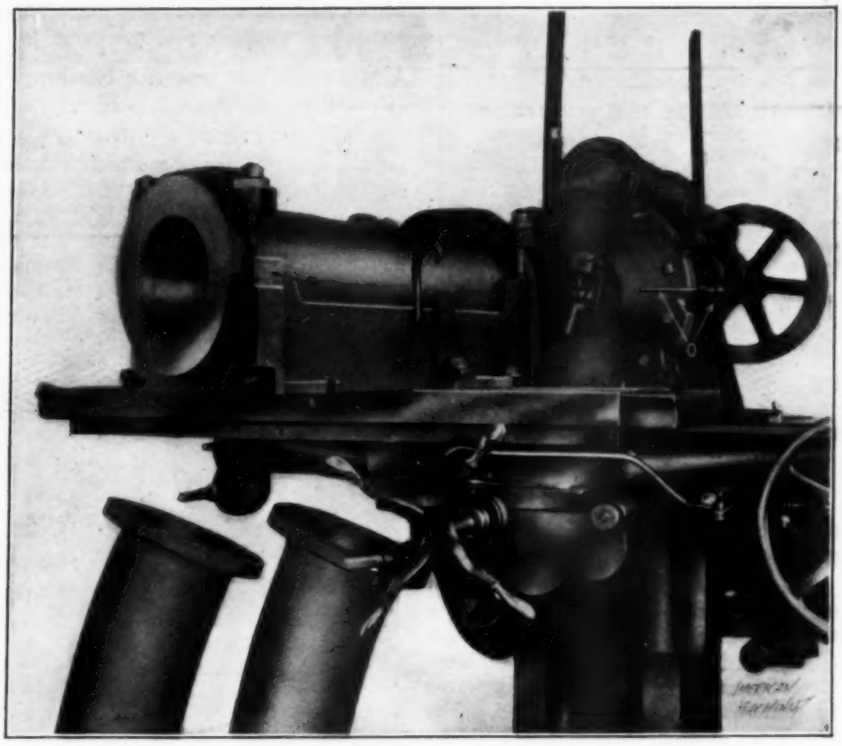


FIG. 4. MILLING THE ENDS OF THE BEND SECTIONS

One of these plates is first put on by resting it on a leveling table, as indicated, and the casting is then turned around so as to be practically level, after which the other jig plate is slipped into place and a through bolt tightened by a nut to draw both jigs up against the work. The jig plates are provided with bosses or hubs which fit the mouth of the hole in the casting and, as will be seen, the method of placing the jigs against the work still resting upon the table assures the dowel-pin holes in the flanges being in line with each other.

After the jig plates are attached, a cradle or yoke is slipped around the center of the casting and the chain hoist operated to bring the work opposite the upright-supporting fixture, shown in Fig. 6. This jig is used under a multiple-spindle drill press and has at the top guiding surfaces to receive the edges of the jig plate attached to the casting which is to be drilled. The casting is so nicely balanced in the sling by which it is hoisted that it is very readily tilted to a vertical position and slid into place in the holding fixture under the drills. It is pushed back until the jig plate strikes a stop and the drills are then fed down through, after which the work is slipped out of the jig, tilted the other end up, slid back into place and the second flange drilled for bolts and alining pins.

Fig. 7 illustrates the method by which the cored hole is ground out to smooth the surface and at the same time kept within the necessary limits of accuracy. The operator here guides the wheel by the finished surface inside the mouth of the hole and although having to grind around a corner, produces results that are entirely satisfactory and within the specified limits of error.

The wheel is mounted on a spindle which passes through a hollow shaft or pipe which the workman holds in his hands. The grooved driving pulley at the rear end of the wheel shaft is belted from a drum overhead and the required tension on the belt maintained by a weight suspended from the bracket carrying the pulley and wheel spindle. An exhaust pipe is connected with each cast-

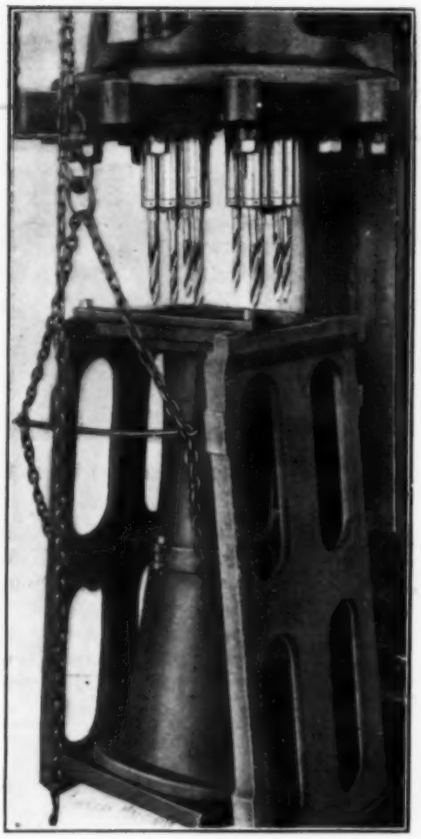


FIG. 6. THE JIG UNDER THE MULTIPLE-SPINDLE DRILL

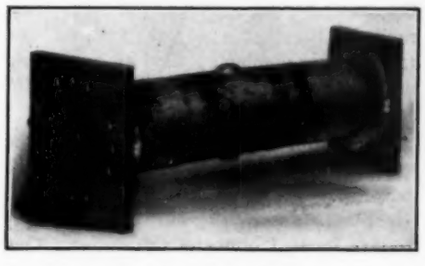


FIG. 5. SETTING THE JIG PLATE ON THE FLANGES

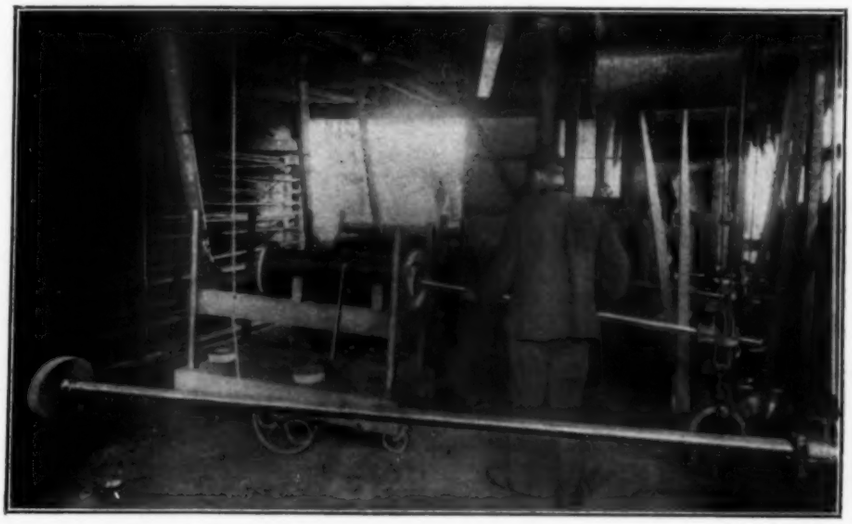


FIG. 7. GRINDING OUT THE CURVED HOLE

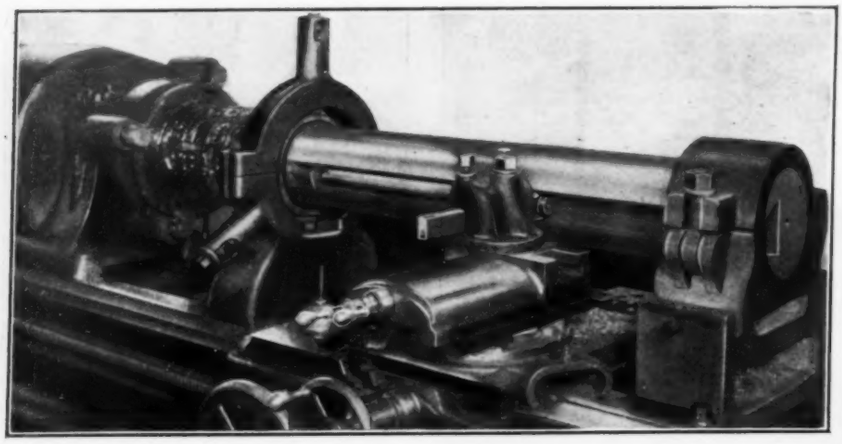


FIG. 8. BORING TAPER HOLE IN TANGENT REDUCER

ing when wheeled into the grinding room on its truck, and the scale and dust are thus carried away from work and operator.

The diameter of the curved hole is tested by a thin steel gage of disk form which is attached to a handle and passed through the work from end to end.

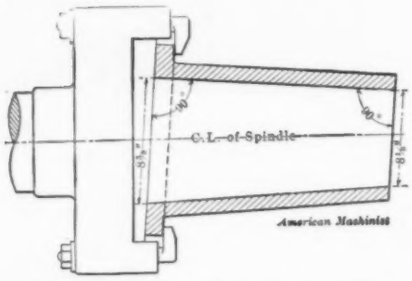


FIG. 9. TANGENT REDUCER SHOWING ANGULARITY OF BORE EXAGGERATED

BORING REDUCERS

The tangent reducer has already been referred to, and a method of boring the taper hole in this casting is illustrated by Figs. 8 and 9. The operation is accomplished in a Lodge & Shipley 27-inch lathe by means of a boring bar which is fixed in position during the boring of each hole.

The reducer casting, which is shown in the sectional view, Fig. 2, is attached to a faceplate fixture by means of four hook bolts, and its outer end which has been turned for a short distance, is supported in the steady rest of the lathe. The boring bar is secured at its outer end by a support on the lathe and is piloted at its inner end in a bushing carried in the fixture which holds the reducer casting. The boring tool itself is fed along a dovetail groove in the bar by means of a rod operated by an attachment carried in the tool post. As the carriage is fed along the shears of the lathe, the boring tool is also fed to the work. The whole bar is set at an angle so that the boring cutter gives the required taper for the hole.

The sectional view in Fig. 9 shows how the work is mounted so that one side of the taper hole shall be finished at 90 degrees angle with the face of the flange which is machined in a preliminary operation. After the hole is bored the hinged clamp on the support at the outer end of the bar is released and the bar slipped out of place by means of the chain hoist whose hook is slipped into the eyebolt midway of the length of the bar.

A MULTIPLE TOOL FOR THE HORIZONTAL MILL

In Fig. 10 is shown a method of turning the nose, facing the end and chamfering the inside of the mouth of a reducer casting while the piece is held on an angle plate and in a three-jaw rest on the table of a horizontal boring machine. The form of the cutters in the head and the method of holding and adjusting them are plainly shown and no description of this apparatus is required.

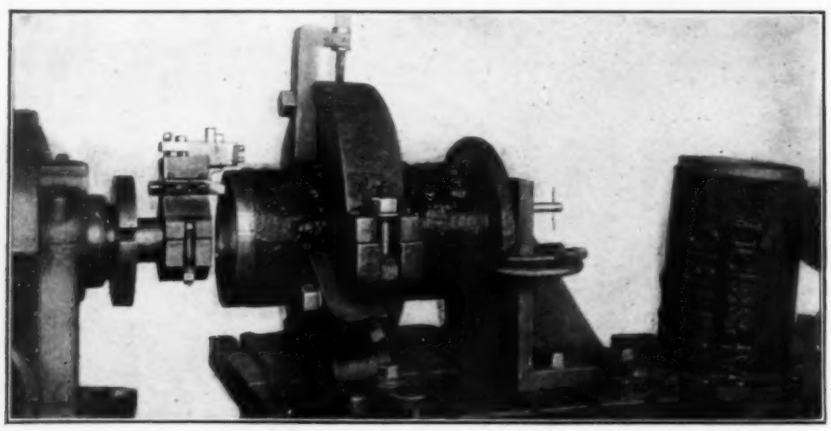


FIG. 10. AN OPERATION WITH MULTIPLE TOOL HOLDER ON THE HORIZONTAL BORING MACHINE

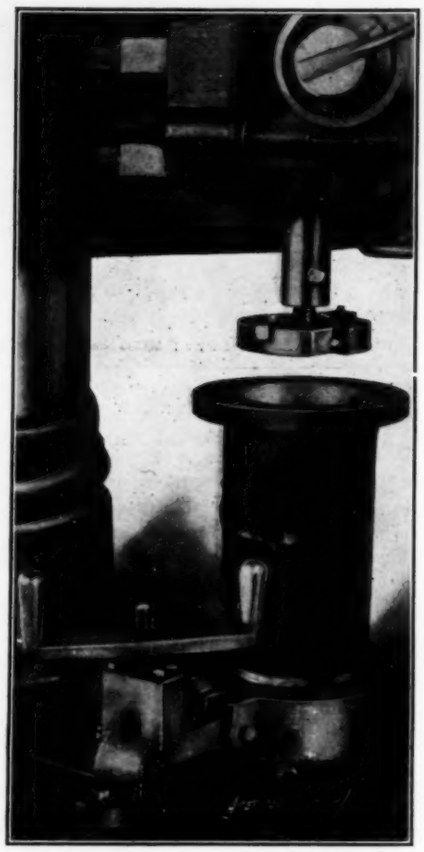


FIG. 11. A BORING JOB UNDER THE RADIAL DRILL

WORK UNDER THE RADIAL DRILL

The casting illustrated in Fig. 11 under the radial drill, is located and held on a large expanding hub operated by turning the crank handle shown at the side. This movement actuates a threaded rod and toggle lever connected with an expanding device which opens the split work holder inside of the casting.

The cutter head seen in place in the spindle is a tool for bell mouthing the hole in the casting and is supported and steadied during the cutting action by rollers located opposite the cutter. One of these rollers is clearly shown in the halftone.

Notes on a Swiss Machine Works

Editorial Correspondence

A general description of the works of Escher Wyss and Cie at Zurich, Switzerland, where Zoelly turbines as well as rotary air compressors and water wheels are manufactured.

The plant where the first Niagara turbines were built.

The plant of the Aktiengesellschaft der Maschinenfabriken von Escher Wyss & Cie., Zurich, Switzerland, is of interest to Americans, for here the first Niagara turbines were built and the drawings for some of the later ones made. The firm is one of the oldest machine-building organizations in Switzerland, having been founded in 1805 by Hans Kaspar Escher, for the purpose of making textile machinery. As time went on other lines were taken up, and thus the first Swiss locomotives and many of the earliest Swiss lake and river steamboats were constructed by this firm.

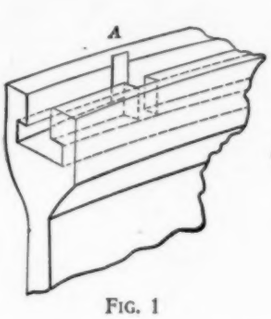


FIG. 1A

FIG. 1

SECTION OF REVERSE AND DETAILS OF DISTANCE PIECE AND WEDGE

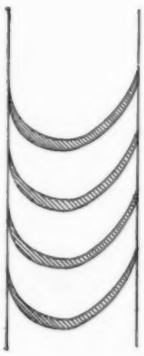


FIG. 2

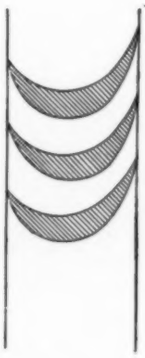


FIG. 3

DETAILS OF BLADES

Later, water turbines were a prominent feature of their product, together with paper mills, machinery, boilers, steam engines, machine tools and power-transmission machinery. At present steam and water turbines, air compressors and refrigerating machinery form an important part of the shop output.

Some 2200 men are employed and another plant is operated at Ravensburg, Germany. At this plant several turbines have been built for war vessels of the German navy.

We were most kindly received by Director Zoelly and shown through the works by one of his engineers, Albert Huguenin.

Much of the work is very large; we note for instance a 10,000-horsepower Zoelly steam turbine for Chartonenbury, three low-pressure rotary blowers for blast furnaces, each requiring a 2200-horsepower direct-connected turbine to drive; ten low-pressure waterwheel sets, of the Francis type, each of 5000 horsepower capacity for Laufenburg on the Rhine, and three 15,000-horsepower high-pressure water turbines of the Pelton type to be used in manufacturing nitrates from the air.

In the design and construction of the steam turbines there are several interesting mechanical details. The rotor disks are of Siemens-Martin steel finished all over, and having a T-groove, Fig. 1, cut in the rim to fasten in the blades. The blades are of nickel steel, milled very thin, tapering toward a larger section at the base in the longer ones, Figs. 2 and 3, and have a T-end to fit the groove in the disk. Between the blades are spacing blocks and the last of these blocks, in combination with a thin wedge, Fig. 1a, acts as a key for the entire rim. The block is held by its T-end fitting partly under the lips of the groove in the rim, and its upper end is staked over the thin wedge so that it cannot come out. The product of successive operations in making the thin blades is shown in Fig. 4.

A great deal of study has been given to the question of critical speeds for the turbine shafts. It is recognized that the running speed and critical speed for a shaft should not be even approximately coincident, else an unstable condition may be set up.

The effect of forcing a number of turbine disks on to a shaft is to stiffen it.

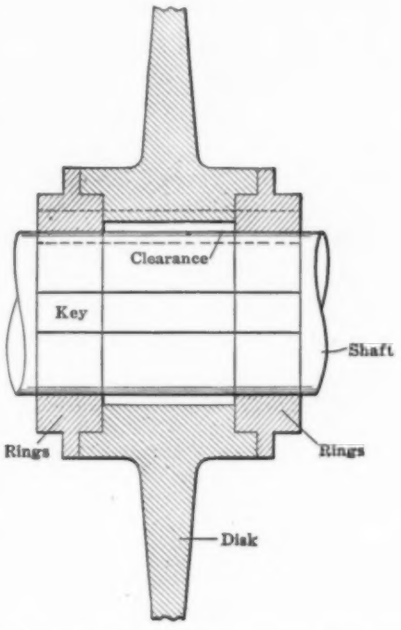


FIG. 5. METHOD OF ATTACHING DISKS TO SHAFT

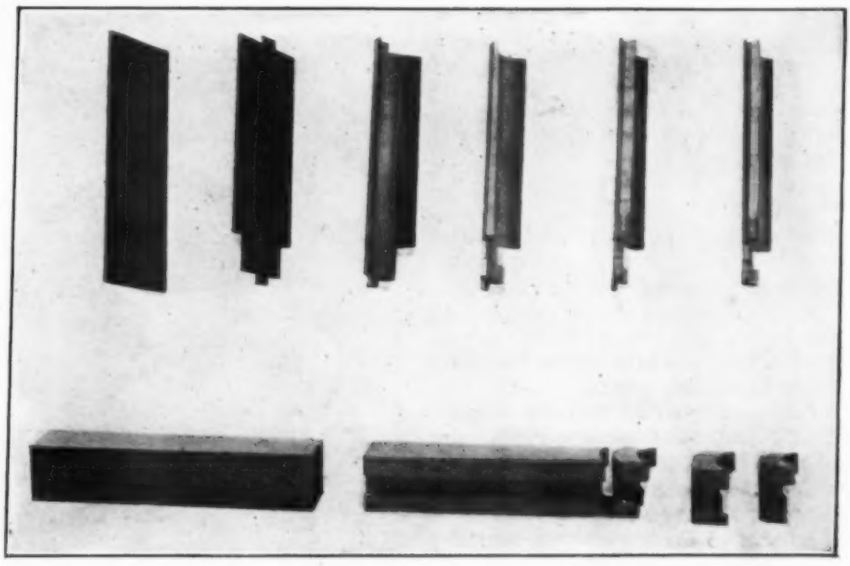


FIG. 4. SUCCESSIVE STEPS IN THE MANUFACTURE OF BLADES AND DISTANCE PIECES

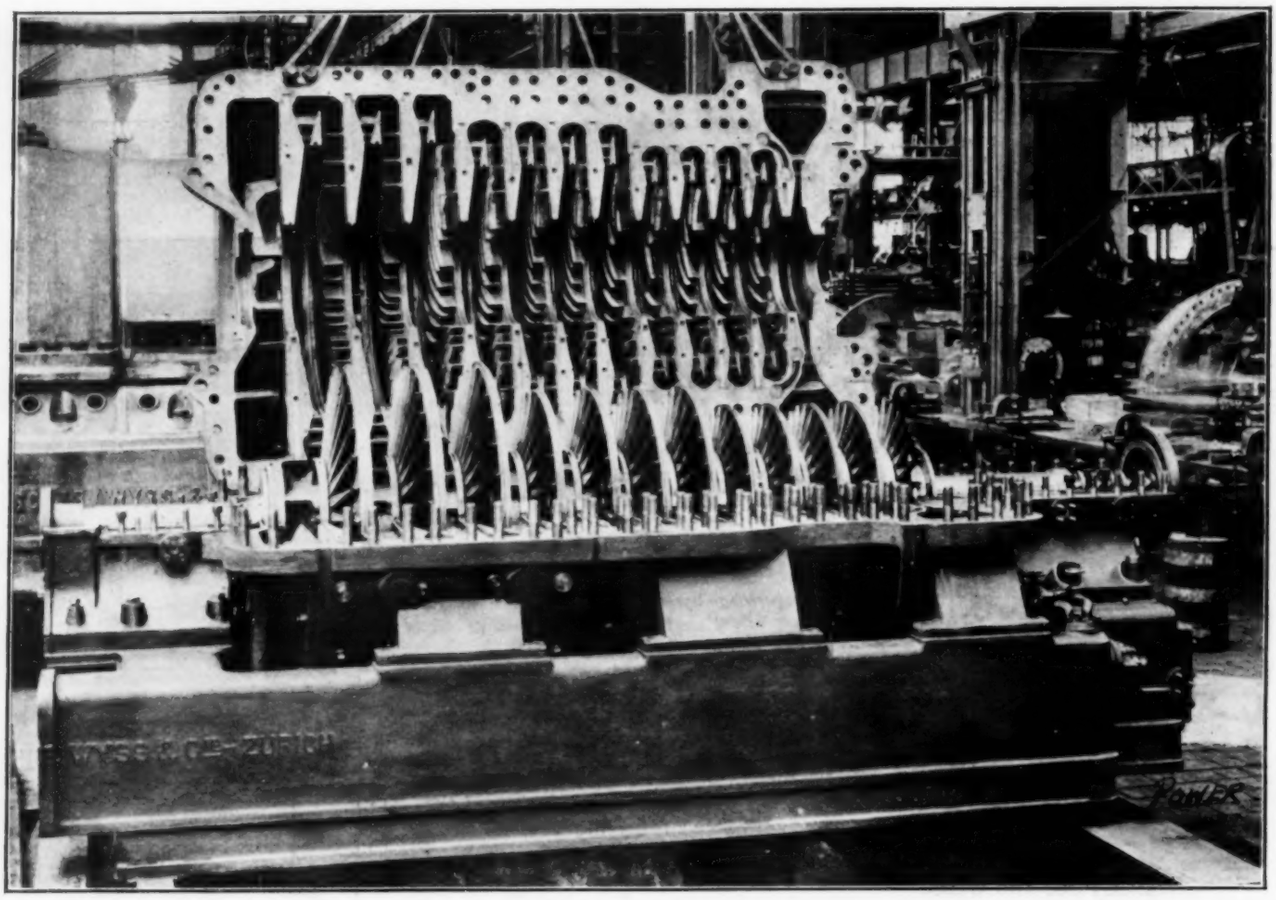


FIG. 6. A 12-STAGE ROTARY AIR COMPRESSOR

thereby raising the critical speed. To overcome this undesirable effect, the bore of the disk is made a clearance size for the shaft and the hub of the disk fits on narrow collars that are keyed to the shaft. Thus the disks do not touch the shaft, and the narrow collars do not stiffen it appreciably and thereby raise the critical speed. This device is shown in Fig. 5.

The turbine-driven blowers for blast furnaces are of especial interest, for a unit having a 2200-horsepower steam turbine, and a capacity of 30,000 cubic feet of free air per minute, and compressing to 18 pounds pressure only weighs with all auxiliaries some 90 tons. This is much less in weight than a steam or gas-driven blower of the same capacity.

The impeller is a steel forging having nickel-steel, sheet-steel blades riveted thereto. The walls between the stages are hollow for cooling water.

The accompanying halftone illustrations, Figs. 6 and 7, show a smaller size with the top casing removed, thus exposing the compressing and diffusing channels, and the rotor removed.

As part of the works is an extensive foundry where both bronze and cast iron are poured, sweeps are used extensively, and it is the universal prac-

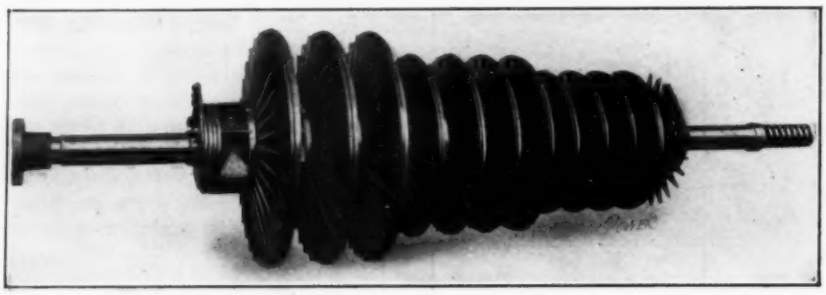


FIG. 7. ROTOR REMOVED FROM CASING

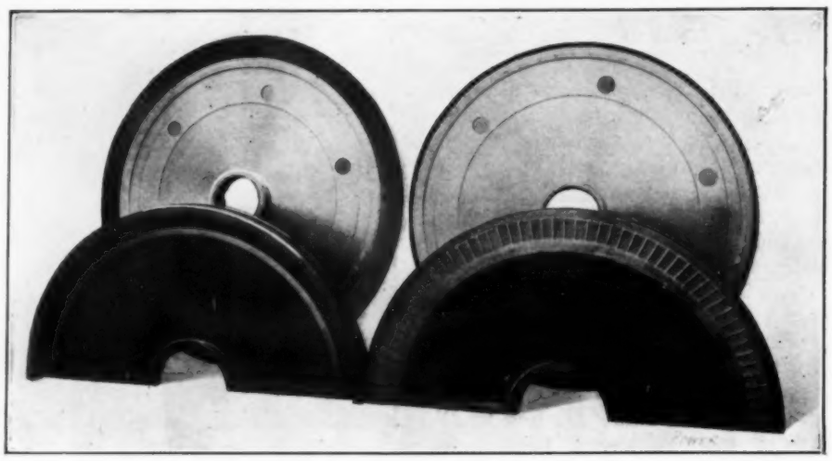
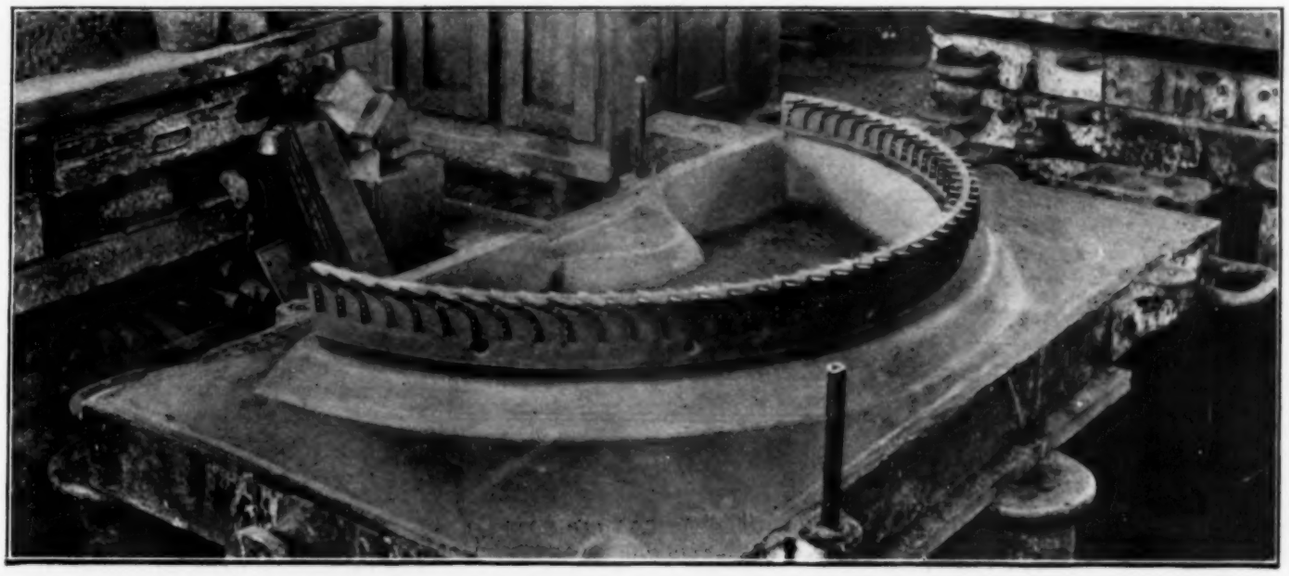


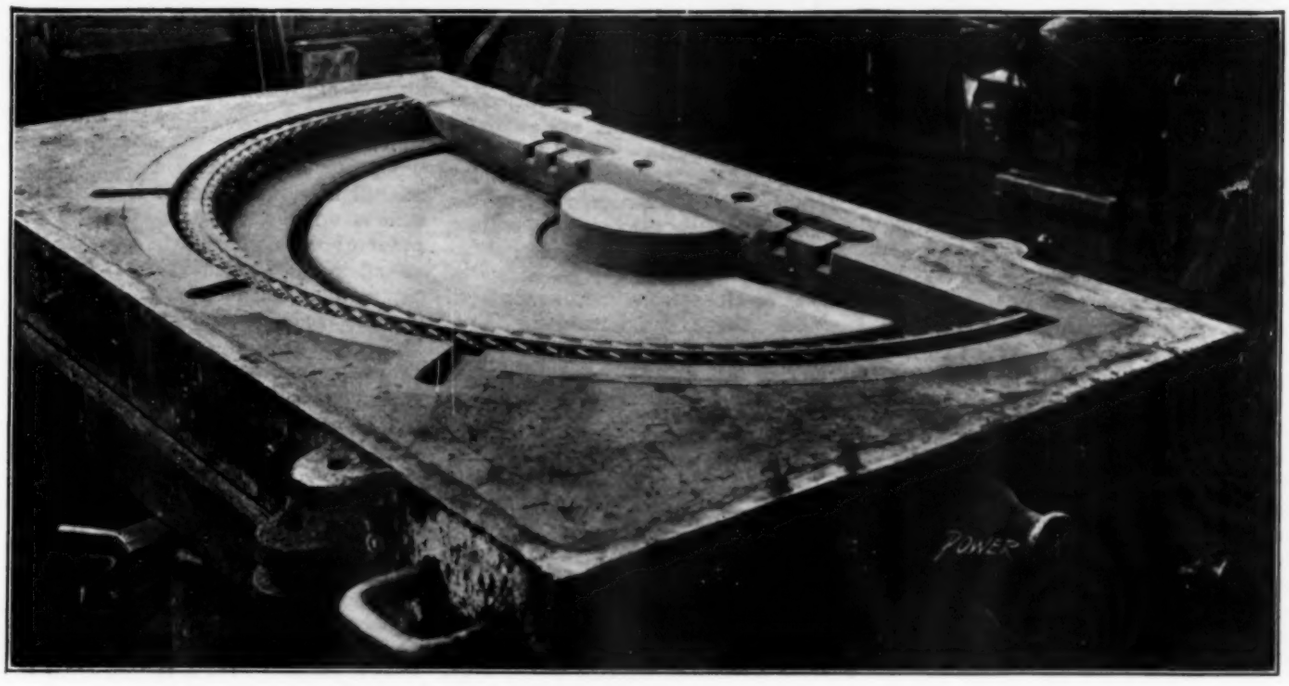
FIG. 8. REVERSE AND GUIDE WHEELS

tice to dry the molds either in ovens, or by torches or salamanders fed with air under a slight pressure.

The fixed blades of the steam turbines and the diffusing vanes of the rotary air compressor are made of sheet steel cast into the retaining disks. As the spacing of these blades and vanes must be accurate, and as the cored openings must be accurate in size, the best of foundry workmanship must be had. In fact metal distance gages are used in setting these curved sheet-metal vanes in the core. Fig. 8 shows in the foreground two segments of guide wheels, and Figs. 9 and 10 the molds for such a wheel with the sheet steel vanes set into the core.

When founding this industry Hans Escher laid down the principle that Swiss industries could only flourish through excellence of design and workmanship of the products, for the country is very small and has no natural resources of coal or iron for machinery building. This principle seems to be at the foundation of Swiss machinery building, and from no other viewpoint except the excellence of labor, can one explain the growth of such a business as this.





FIGS. 9 AND 10. GUIDE WHEEL CASTINGS IN THE FOUNDRY

Fuel Oil in British Navy

The steadily growing use of fuel oil on British ships has resulted in polluting the harbors to such an extent that the Admiralty has ordered that precautions be taken to prevent its leakage or discharge into the waters of all British ports.

Cutting Lubricants for High Speed Automatic Machines

The following formulas are being recommended by users of different kinds of machinery, as good cutting compounds at a low cost.

A formula which is said not to gum or hold the oxide of iron or dirt in suspension, is not affected by cold weather and does not adhere to chips, is 30 per cent. kerosene and 70 per cent. mineral lard oil.

A mixture of 40 per cent. fuel oil and 60 per cent. mineral lard oil is recommended as even better when the fuel oil is of a grade that is light in weight, flows easily and is free from sediment.

Cost Keeping for Small Machine Shops

By Sterling H. Bunnell*

By a simple card system, it is possible to keep accurate cost records without excessive bookkeeping.

Three methods of apportioning the "Shop Burden" or General Expense: By percentage of labor and material, by hourly rate, or by charging for the use of tools according to value of equipment occupied.

In the reduction of cost accounting to a science, the needs of the large factory have been fully considered, but little attention has been given to the requirements of the small shop. The proprietor of the small machine shop should ascertain costs as accurately as the corporation operating a large works; for while the small organization has less at stake, it is less able to withstand the effect of serious errors. While the small shop may not be able to afford a force of cost clerks and a complete cost department, the bookkeeper necessarily employed on accounts and pay rolls, may be made available for cost keeping under a simplified system. Properly directed, the shop bookkeeper can take care of the cost accounts without adding materially to his labors.

The small shop wants its costs kept as accurately as the costs of the large factory. The essential difference is in the volume of work. The small shop will need less duplicate copies, less indexing, and less tabulation and preparation of records for rapid scrutiny by department heads. In brief, the small shop can reduce its cost keeping to the lowest terms, using the ticket system which is the basis of the most complete and modern cost accounting, by making the tickets serve as the complete record, and thus eliminating most of the clerical work which is essential in the large plant.

Every item of labor is to be entered on a separate job ticket, a simple form printed on a 3x5-inch tagboard slip. These cards can be filed in standard index file drawers. Each workman makes out his own time in pencil on these cards, one card for each lot and kind of work. No card is allowed to run over from one day to the next; a job unfinished at closing time is reported by a job ticket marked "N.F." (not finished) and another ticket is made out on the following day continuing the job. The job tickets for each man are placed together at the end of the day's work, or the first thing the following morning, and the number of hours worked is checked against the timeclock or timekeeper's record. These job tickets serve as a basis for the pay roll. Having completed the pay roll for the day, the cards are ready for redistribution and filing away by order numbers.

Materials and all incidental charges are reported on similar tickets, but of different color and with appropriate printed form. Each issue of stock for work is entered on a material ticket. These tickets serve also for recording direct sundry expenses, such as car fares and small purchases. Large invoices of material intended for specific orders are charged up through the medium of the same material ticket forms. Each day, the previous day's tickets are run over and priced, sorted by order numbers, and filed away in trays or drawers with the labor cards.

*Works manager, Griscom-Spencer Company, New York City.

As each order is finished, its cost is ready at hand by a reference to the tickets in the drawer. The lot of tickets is taken out, spread out on the desk, and totaled and charged to the customer in any desired form. If the work was by contract, or charged at a fixed price, the material and labor tickets are totaled separately, and the amounts entered on the books to show the cost of the order as compared with the selling price.

Shop Burden by Percentage

Direct expense, as accountants term these material and labor items, forms, however, but part of the cost of running the shop.

In the first beginning of shop organization, where the foreman is proprietor and works with his own hands among his men, there is no indirect or non-productive labor. Natural development into the shop employing a force of workers, as distinguished from the primary workman performing his task on his own premises, introduces expenses which cannot be charged directly to the cost of the work. Heat and light must be provided for the general good of the workers; helpers are necessary to lend a hand when required, and to keep the premises clean; and power and supplies must be furnished. As it is not possible to divide the amounts of coal and oil, waste and rags, foremen's wages, taxes and insurance, and all the rest, among the various jobs going through the shop, some arbitrary basis must be arranged by which sums may be added to the material and labor costs of the orders, which together shall make up an amount approximately equal to the undistributable expense. Items which do not occur every month, such as insurance and taxes, and items which are matters of accounting, though none the less real than bills from creditors, such as depreciation allowances, should be estimated in advance, and arranged for proportionately in the expense account month by month. The running expense of the shop is in this way reduced to a uniform schedule, varying from month to month only as caused by variation in output of the works.

The ticket system affords a convenient means for apportioning indirect expense or "burden" by any of the several methods in use. There are three well defined methods, each applicable under certain conditions. The first is apportionment by percentage. The average shop expense is compared with the average expenditure for direct labor, and the ratio reduced to a percentage, which percentage is added to the cost of direct labor on each factory order. To illustrate, it may be found in a certain shop that the monthly operating expense, outside of material and labor charged direct, amounts to about one-half the monthly pay roll. Distribution on the percentage basis would require that 50 per cent. of the direct labor cost of each order be added to the net or prime cost, as the proper apportionment of burden. This method is common, but it is subject to serious error, because it takes no account of the difference in expense involved in operating large tools as compared with small tools, and charges less expense for a low-priced man than for a high-priced man, although both use the very same tool equipment. It is, therefore, correct only for work done by a single class of workers all receiving the same rate of pay and using similar tool equipments.

Shop Burden by Hourly Rate

Another method of charging burden is by the hourly rate. The average monthly expense is divided by the average working hours, and the quotient is taken as an hourly charge to be made for the use of shop equipment. On a factory order involving one hundred hours direct labor, there is made a charge of one hundred hours of burden at the hourly rate. The inaccuracy in this system is in its failure to take account of the difference in the value of the several tools and hand-working equipments, so that the same charge is made for a small tool as for a large and more expensive one. This method is correct only where all tool equipments are substantially the same.

Burden Modified to Suit Tool Value

The third method, for practical purposes in the small shop as well as in the large one, is preferable to the others. It may be called the modified hourly rate method. It is very important that the true cost of doing work should be known, as otherwise there will be a tendency to quote unprofitable prices for work using large, expensive tools, and therefore to secure such work and do it at a loss, while on the contrary quoting too high and losing work suitable for the cheap equipment. Practical accuracy in estimating cost is secured by suiting the hourly rate to the character of the tool equipments used on the job. This is easily done by setting two or more rates and assigning them to the several tools according to their expense of operation.

To derive correct hourly rates, the expense account should be carefully gone over for two or three months, and variations equalized, so that the expense account of one month will not appear unduly high merely because a car of coal, for instance, arrived a day too soon or too late. The various tool equipments of the factory are then numbered, and the numbers set down in tabular form. Opposite the numbers, columns are provided in which the items of expense may be entered. The first column carries the expense connected with the building. The total rental for the building, or the interest on its value, together with taxes, repairs, etc., is reduced to a monthly basis, and apportioned to the several tool equipments according to the floor space occupied in the operation of each. The total of this column is, therefore, equal to the monthly cost connected with the maintenance of the building. In the next column is entered the depreciation and repair allowance for each tool equipment, based on the probable length of useful life of the machine, and the probable outlay for repairs averaged over the whole time, all on a monthly basis.

In the next column the cost of power for each tool is set down. The average power required by the tool is multiplied by its average working hours per month, giving horsepower hours, and these are totaled to give the horsepower-hours that are required to run the shop. The cost per horsepower-hour is then readily obtained from the cost of operating the power plant, comprising fuel, labor, repairs, depreciation and other expense. It is convenient to group the costs of heat, light and water with the power cost. The cost in cents per horsepower-hour is then multiplied by the average hours worked by each tool per month, to give the monthly cost of power for each. There remain some miscellaneous expenses, bearing a small proportion to the rest, which may be apportioned on any convenient basis giving reasonable accuracy, as by the square foot, or conveniently by the value of the respective tools. It is reasonably correct to assume for this portion of the expense account, that large tools costing more and occupying more space, will require more of the miscellaneous expense for their operation. This disposes of the unclassified expense.

The monthly amounts are now added across and the total set in the next column. These totals, divided by the corresponding average monthly hours worked, give hourly rates, different for each tool. As there will be some rates falling close together, it will be possible to run over the column and group the rates into two, three, or four classes, substituting for each class an average hourly rate in round numbers, which should be charged for all the tools in the class.

In this way, it may be found that all small cheap hand equipments, such as bench space involving a vise and a few files only, shall be charged for at a rate of, say 10 cents per hour. Small lathes, drills and milling machines will perhaps cost 20 cents per hour to operate. Three classes will probably be quite enough for any small shop.

The Bookkeeping

The burden is actually charged by entering the amount on each separate job ticket. Thus, a ticket comes in from man No. 11, operating tool No. 5A, which happens to be a 16-inch lathe, and the time, 2 hours. The man's rate being 30 cents per hour, the labor cost is entered on the ticket as 60 cents, and class A burden being 10 cents per hour, the burden is entered on the same ticket as 20 cents. For convenience, the several classes having different burdens are lettered, the letter affixed to the tool number and so conveniently entered on the job ticket.

The cost of each order is thus made up of material, labor, and burden. The bookkeeper finds it easy to carry a sheet or book ruled in columns, known as the Register of Completed Orders; and to enter the number of each order as it is completed, with the cost of material, labor and burden, and opposite, the total and the selling price. This book is footed up monthly, and the totals of the several columns, added to the total of the cards for uncompleted orders in the works, are compared with the totals of the general accounts. The total material used during the month, subtracted from the total on hand at the beginning of the month, plus purchases, shows the book value of materials remaining on hand. The total of the direct labor, added to the total of all expense labor, should agree closely with the month's pay roll, allowing a small discrepancy for fractions of cents rejected in computations. The total of burden should agree more or less closely with the total expenditure on account of expense, the allowance for depreciation being added. For convenience in making these comparisons and in balancing the outlay for material and labor against cost, every helper, foreman, watchman or other employee whose labor cannot be charged direct to the cost of paying factory work, reports his time on the regular job tickets under the title of Expense, or under a convenient number or symbol. Material used indirectly on general shop upkeep is charged similarly on regular material tickets. All these tickets are sorted like the rest and kept in the same file under the head of Expense.

Applied to the Small Shop

The ticket system as described is the same for the small shop as for the largest manufacturing plant. In the large works, a force of cost clerks foot up the tickets day by day and transcribe their totals to separate cost books for easy reference. The small shop can well dispense with this part of the work, and with a little more care in insuring clean and legible tickets, may have equally accurate cost records at no more expense than is required merely for time-keeping and paying for labor, and checking material as it is issued for work.

Which Side Up for the Adjustable S-Wrench?

There are in common use in most machine shops, various sizes of adjustable single-end S-wrenches, which are made with a nurled thumb-boss on a right and left adjusting screw, which lies crosswise of the wrench jaws. By moving the screw in one or the other direction, the jaws of the wrench will be opened or closed. So far so good, but those wrenches often prove a source of aggravation to the mechanic, especially when he is working against time.

When the nurled boss or hub is turned by the thumb, that wrench either opens or closes its jaws; but which? That is a question which nine out of ten machinists cannot answer when they commence to turn the thumb-hub. They wait and see which way the jaws move, and then usually turn the screw in the opposite direction to obtain the required adjustment. "Strange, but true" how the wrench in question almost always moves in exactly the wrong direction; strongly provocative of profanity in many instances.

But there is a very simple way by means of which the direction of the jaw-movement may be predetermined without fail. The wrench is, as stated, of the S variety, and having but one working end, the bend in the wrench must fit in the hand better with a certain side upward, than when the wrench is the other side up. The thumb is in a better position, and lies more naturally when the convex portion of the handle is toward the thumb of the right hand.

Letters from Practical Men

Direction of Motion of Gears

In machines having a large number of gears in a train or trains, as in printing presses, wood-working machines, paper-bag machines, clock work and the like, it is often necessary to know from the drawings the direction of motion of some particular wheel in the train. For instance, in the sketch accompanying these notes, in which the dot-and-dash circles represent the pitch circles of the

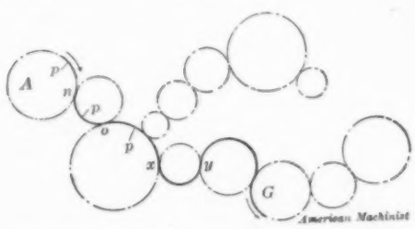


DIAGRAM ILLUSTRATING DIRECTION OF MOTION OF GEARS OF A TRAIN

gears, it is required to know the direction of motion of the gear *G*, that of *A* being known.

Some people draw little arrows near each circle until they come to the required gear *G*. The easier and quicker way, however, is to follow with a pointer or similar implement, starting on *A* in the direction of the arrow *m*, along the line *p*, tracing on each gear only from the point of contact of one pair to the point of contact of the next pair, as for instance, *n* to *o*, *o* to *x*, *x* to *y*, etc., to the gear whose direction is required, all of which can be done in one-quarter of the time it takes to tell about it. I find that few people I have met have ever heard

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

of this way of finding the direction of motion of wheels and when it is shown to them they are always surprised and "taken" by its quickness.

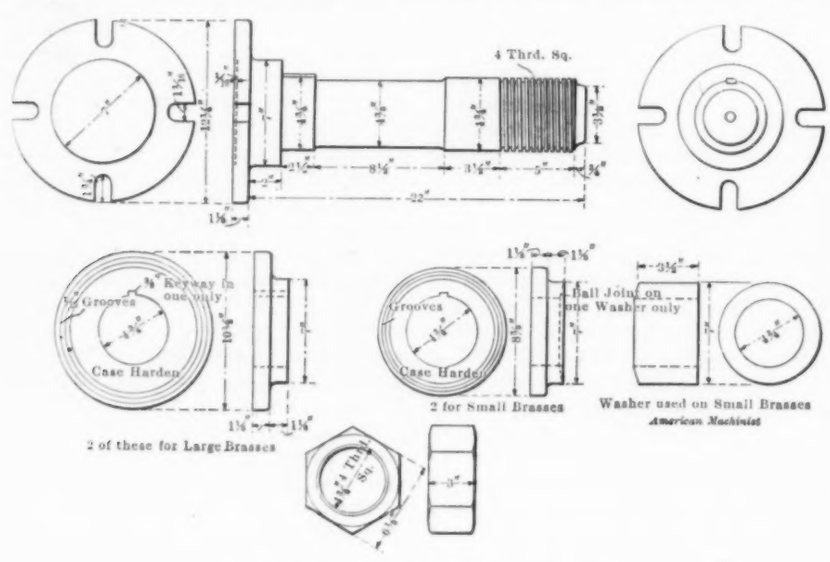
Brooklyn, N. Y. C. D. K.

Mandrel for Turning Locomotive Driving Box Brasses

Attached print shows mandrel used on lathe to turn driving-box brasses. For ease of operation and solid construction, it is a success. This arbor will turn brasses for 9x12-inch journals in 12 minutes, taking two cuts. The secret of its success is that it is bolted to the face plate by two 1-inch bolts and held central by the recess shown in the end of the arbor. The brass is held in position against the two washers when the nut is set up by a long-handled wrench. Most shops use the mandrel held on both lathe centers and driven by a dog on the end of the mandrel, which makes it very unsteady and not nearly as rigid as the one shown.

W. J. SHADLE.

C. & N. W. R. R., Clinton, Iowa.



A MANDREL FOR DRIVING-BOX BRASSES

Black versus Red Dimension Lines

As a draftsman of some experience, I have found that in most drafting rooms,

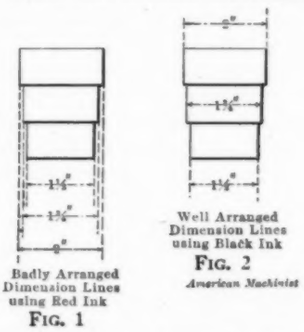


FIG. 1

DIMENSIONING WITH RED OR BLACK INK

FIG. 2

black dimension lines have been given preference. In many places one will find red lines on old drawings but the use of that ink has been abandoned altogether. There are several reasons for this, but again, there are advantages in using red lines.

Taking the advantages into consideration first; it undoubtedly makes the tracing ever so much clearer and it hardly takes longer to use two kinds of ink, especially if the draftsman uses two drawing pens. Some people's objections are that red does not show up very well in the blueprint, yet if only a little care is taken that the ink flows right, a red line can be drawn very fine, and still show up nicely in the print.

In that case there will be just a clear distinction between construction and dimension lines, making it easy to read the print. This is of great importance in a complicated assembly drawing, when only few details are drawn out. It has been found, however, that red ink is very hard to erase and this has caused considerable trouble, in places where frequent changing of the design, and, of course, the tracing, is almost unavoidable.

Two colors of ink are furthermore misleading in so far as a certain way of arranging the dimension lines may look well enough on the tracing, having construction lines and dimension lines of different colors (see Fig. 1), but would look badly on the print, having the lines too close together. If black ink had been used, the draftsman would have taken

more care in putting in his dimensions, for the simple reason of making his tracing plainer. See Fig. 2.

Probably on account of the difficulty of erasing red ink and the fact that the use of red ink may be the cause of badly arranged dimension lines, also the fact that a fine black line will produce the same effect on the blueprint, which should be first consideration, the black ink is being used more frequently. As far as the clearness of the tracing is concerned, the draftsman might spend a minute or two more in studying a drawing and in carefully arranging his dimensions, as it will doubly pay to give the workman as clear a print as possible.

Hartford, Conn. J. C. P. BODE.

Accurate Flat Grinding on a Cylindrical Grinder

In finishing surfaces to the extreme point of accuracy the grinding machine is an indispensable tool, but as the greater

ACCURATE FLAT GRINDING

portion of work that is finished by the process of grinding is of a cylindrical form, little mention has been made of finishing straight flat surfaces to a point of accuracy, where variation is reduced to a minimum.

The accompanying photograph shows a gage ground on both sides, *A*, and which was found not to vary in thickness as much as 0.0001. The surfaces were then rubbed perfectly dry with a chamois skin and the blocks *B*, shown clinging to the surface, were taken from a set of "Johannson" gages, mention of which was made in the AMERICAN MACHINIST. In order to accomplish this feat it is obvious that in order to hold these blocks the surface must be absolutely flat. The piece was clamped to the face plate by means of a hole drilled in each end, and ground on a No. 1½ Landis universal grinder.

Waynesboro, Penn. W. G. NEVIN.

Securing Locomotive Eccentrics

Having been connected with locomotive shops for years and having had considerable trouble with eccentrics coming loose and causing breakdowns, I submit what I think is the best way of retaining eccentrics.

This drawing does not show a cotter key above the jam nut but as it was made by one of my apprentices, I think we will be compelled to excuse him, as this is one of his first attempts.

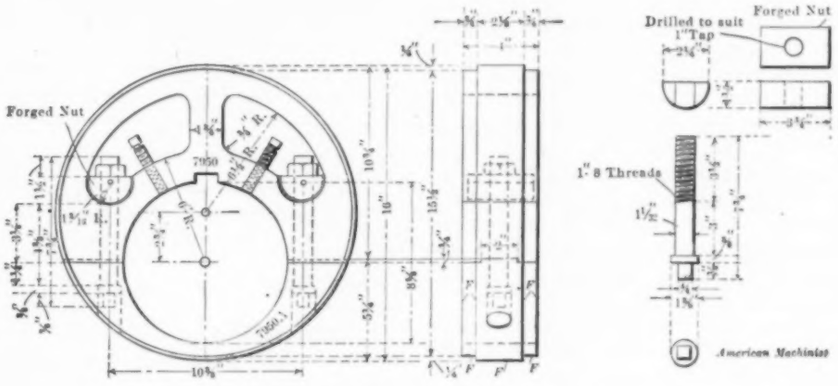
You will note that the forged nut is tapped 1 inch and a faced 1-inch hex nut is jammed down on top of it. It should show a ¼-inch cotter key on top of the 1-inch hex jam nut.

I have been operating 36 engines for the past four years equipped in this way and have never had an engine failure due to eccentric trouble.

W. D. BUNKER.
M. M., C. & W. R. R.

Device for Oiling Stock for Press Work

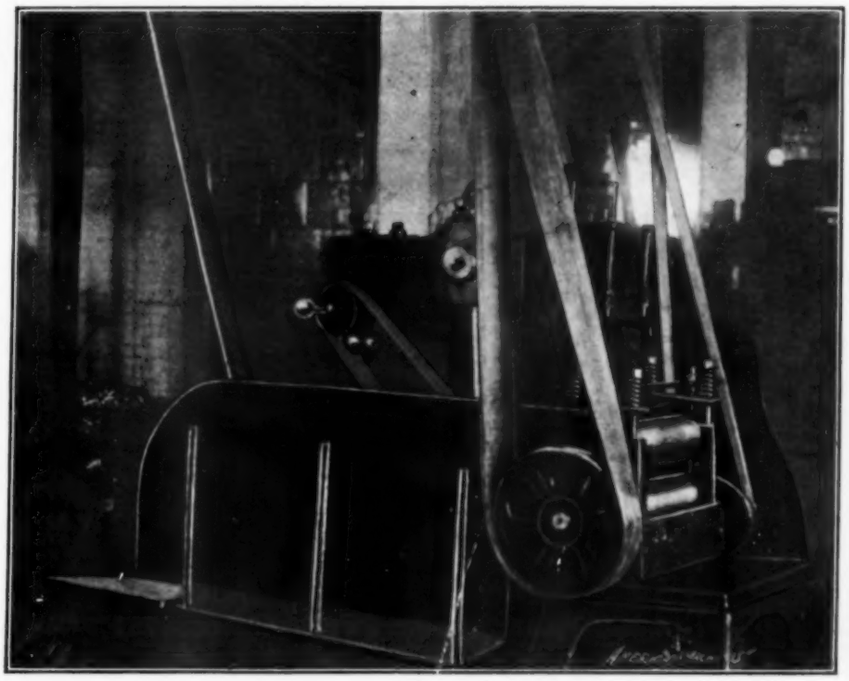
We note in a recent issue a device for oiling plate for press work. This brings to mind a similar contrivance which we are using, with good results.



LOCOMOTIVE ECCENTRIC BOLT AND NUT

Our device comprises a pan or box for the lower rolls, which is kept partly filled with oil, and a small oil pump and distributing pipe for the top roll, keeping this covered with oil. The rolls, instead of being covered with felt, are plain cast-iron cylinders, rough turned.

The tension on the springs holds these together so that oil is left on both sides



DEVICE FOR OILING STOCK FOR PRESS WORK

of the plate, as it passes between the rolls. In operation this will oil plate about as fast as a man can feed it through.

The excess oil runs from the table back to the reservoir where it is pumped once more to rolls.

Worcester, Mass. E. HOWARD REED.

Oiling Sheet Metal for the Punch Press

I have seen a device somewhat similar to that described by S. C. McKeown on page 360, for oiling sheet metal for the punch press. The device I refer to is identical with the one shown in the sketch, except that it has no belt or pulley and that the lower roller is so situated that it is kept saturated by the oil in the drip pan underneath, while a reservoir located on top of the apparatus does a similar service for the upper roller.

One of these machines is provided for each punch press and so located that the action of the feed mechanism pulls the stock through the oiler.

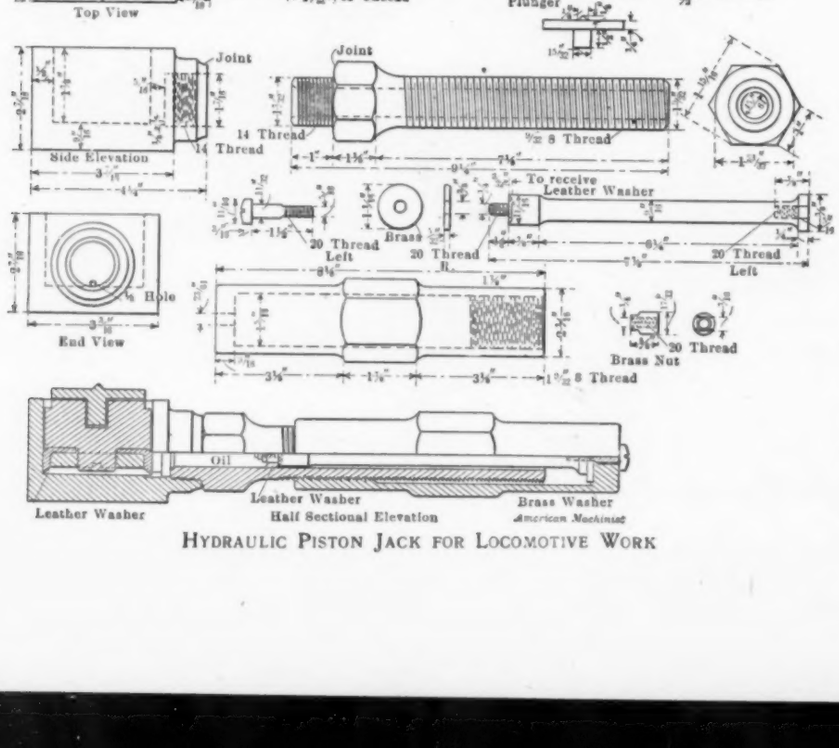
Sheet metal both in strips and in rolls has been oiled by this method for a number of years with entire success.

Oneida, N. Y. A. R. C.

Hydraulic Piston Jack for Locomotive Shop

The accompanying drawing shows a hydraulic jack which is used to remove piston rods from crossheads, valve-rod pins and rod bolts. Complete details are given and will be found very useful in any railway shop.

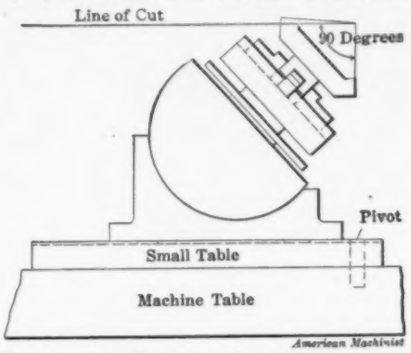
W. J. SHADLE,
Clinton, Ia. Shop Foreman.



HYDRAULIC PISTON JACK FOR LOCOMOTIVE WORK

Fixture for Cutting Miter Gears

The following method for cutting the teeth in miter-gear blanks, on a No. 2 plain milling machine with a universal head, is giving us good results. The gears are mild steel, 37 teeth, 6 pitch. They are finished in two cuts and do not require filing. They wear well and run quietly.



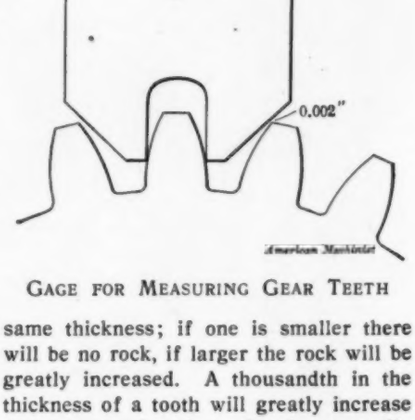
FIXTURE FOR CUTTING MITER GEARS ON A PLAIN MILLING MACHINE

A small table with a groove up the center for the head is secured to the machine table, a ⅝-inch pin being in one end acting as a pivot about which the small table is free to swing. After the blank is set this table is strapped securely. The face and cut angles of a miter gear together make 90 degrees, and it follows that when the blank is set up for cutting, the apex of the cone angle is in a vertical line with the face of the blank. The blank is set so that this vertical line falls in the center of the ⅝-inch pin. The table with head is now swung either way an amount that will give a correctly shaped tooth on that side. After going around, swing the table the same amount in the other direction. Of course, the cutter must be set in position before the table is swung either way. The amount to set the table over will have to be found by trial, but once found the same marks will answer for any size miter gear. The sketch shows this arrangement.

Hamilton, Ont. W. A.

A Gage for Gear Teeth

If you want to make a gage for trying the width of gear teeth to see if they are the same width as sample or if all the teeth of a gear are the same width, etc., one can be quickly made by taking a piece of sheet metal 1/32 inch thick, cutting it out as shown in the cut and fitting it over a tooth so there is just a little rock, say, 0.002 inch, between the sides of the gage and the two teeth adjoining the one the gage is on. If all the teeth tried show the same amount of rock they are the same thickness; if one is smaller there will be no rock, if larger the rock will be greatly increased. A thousandth in the thickness of a tooth will greatly increase the amount of rock so that it can easily be detected.



GAGE FOR MEASURING GEAR TEETH

This gage is especially useful if you are cutting a gear and have any doubt of the accuracy of your index head.

Baltimore, Md. F. E. FICK.

An Unusual Case of Corrosion

A recently issued British Board of Trade report deals with a singular example of rapid corrosion in the marine boilers of the S. S. "Liverpool." Steam is supplied by two Scotch boilers, single ended, 12 feet 8 inches diameter by 10 feet 6 inches long. There are in each three corrugated furnaces, 3 feet in diameter inside. There are three separate uptakes. There are in each boiler 66 stay tubes, 3¼ inches external diameter and 5/16 inch thick, and 166 plain tubes of the same diameter, and 9 W. G. = 0.144 inch thick. In less than one year the whole of the plain tubes were practically rusted out, and this was not due to pitting.

Discussion of Previous Question

Flats on Hobbed Gear Teeth

While I am not in the gear business, either as a maker or user, I have a mechanical interest in the subject and wish to inject a few words into the discussion or presentation of the subject, now going on in the AMERICAN MACHINIST.

When Mr. Grant set forth that the hobbed gear was a succession of flats, the thought that at once came to me was: what else was the Bilgram, Gleason and Fellows? And then, believing as I do after thirty years of observation, that a rough bored engine cylinder is better than a smooth one, I wondered whether a rough tooth, provided one tooth was to slide over the other, was not also better than a smooth one. However, I won't stop to argue this, as I would not make gearing with a view to having one tooth slide over another when new.

If a gear tooth, or say a pair of gears are theoretically correct and perfectly made, they will be at their best to start with; will be pretty good for some time after, and keep getting worse and worse as long as they last. Now, were it possible to determine the correct form so as to have them pretty good to start with, of perfect form when partly worn and pretty good after, then the "pretty good" would be twice as long as in the case of the one that was perfect at the start.

To do this the tooth would have to be prominent at the pitch line; in fact, of such form that for the greater part of the time there would be only one pair in contact, and at no time but two. This would concentrate the strain on a single tooth (perhaps an objection) but on the other hand, the movement between the teeth while in contact would be very slight, and the wear reduced to a minimum. In addition to this, if the wheels and pinions were accurately spaced they would run quietly. A certain pair of gears that made a racket were recut with cutters having a radius so small that they had only line contacts at the pitch line. The result was that they ran almost noiselessly, and after three years' use showed wear only on the pitch lines of the teeth.

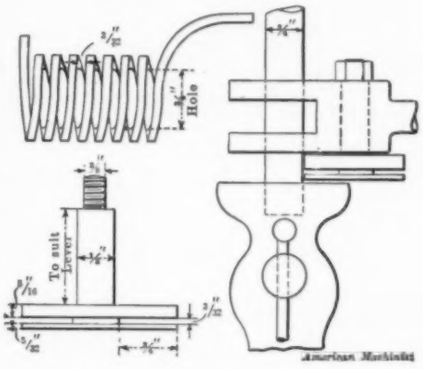
About the question of angle; if it were not for interference, one would naturally prefer no angle at all, as there would then be no thrust against the journals; but there are two reasons why this would not be good; the interference when a small pinion is used, and the weakness of the undercut teeth. As to this last objection, when the teeth act in one direction only, the Yale & Towne people have had the courage to overcome that in their traveling crane gearing, by making the front, or working side of the teeth as usual and the back of the teeth at a great angle; 30 degrees, or 45 degrees perhaps, rendering the teeth vigorously strong, and also eliminating interference.

Syracuse, N. Y. JOHN E. SWEET.

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Jig for Winding Coils

When reading your article describing the winding of flat copper strip coils, which appeared on page 113, I was reminded of a job I had to do some time ago, namely; to wind a few overload coils for motor starters, as shown in the sketch. The boss did not want to go to much expense for tools, so I rigged up the jig as in the sketch, which I think explains itself.



JIG FOR WINDING COPPER COILS

In winding the coils, which had to have a ¾-inch hole through them to clean the core when assembled, I first placed the mandrel in the vise with lever upon it; then I threaded the copper strip through groove in roller and fastened it to jaws of the vise with a pair of parallel clamps, leaving it long enough to bend as shown, when wound. I then wound the coil, putting plenty of oil on strip as it went through the roller.

When wound, I slacked off vise and withdrew the mandrel from the coil, when the jig came away, making a very satisfactory job.

Birmingham, Eng. A. GALE.

Making Small Grinding Wheels

Articles on pages 219 and 457 relative to the above subject have been brought to our attention. We have nothing to say regarding the method of making internal wheels out of pieces of larger wheels, but are surprised that this most unsatisfactory and expensive practice continues at all.

Mr. Phillips states that "Such wheels cut more freely in the smaller sizes than those that are bought." Evidently Mr. Phillips is not aware that progressive wheel manufacturers can, and do, make internal wheels of any fineness and hardness desired. It is true that formerly it was customary for wheel manufacturers to make these small wheels in iron molds under pressure. This produced a sort of scale on the sides of the wheels that was objectionable, but it is now possible to make these wheels by a different method that does away with that objection. In other words, internal wheels can be made to exactly meet the conditions of internal grinding, and be as porous and free cutting as desired. As large wheels are seldom of the correct grain and grade for internal grinding, the operator who makes his small wheels from large wheels, after all his effort, stands little chance of producing the most inefficient wheel.

It is doubtful if an internal wheel 1x⅜x⅝x1½ inches, for example, could be produced from a piece of a larger wheel in an hour's time, to say nothing of the time required to sharpen or repair the cutting tools. A wheel of these dimensions, of the correct grain and grade to give the best results, can be purchased from the wheel manufacturer for ten and one-half cents. W. E. RICHMOND.

American Emery Wheel Works.

Planing with a Former

The rig shown for this purpose by R. L. Haselgrove on page 460 is not drawn correctly. The former there shown is apparently of the same radius as the piece to be planed, whereas the radius of the former, when used as Mr. Haselgrove proposes, should be equal to the sum of the three radii, viz., of the work, of the tool and of the copying roller. If Mr. Haselgrove had made his former convex instead of concave, with the convex side

up, and the copying roller resting on top of it, with a weight directly on the tool slide to hold it down, and also made his tool of the same radius as the copying roller, then his former could be an exact duplicate of his work, both in size and shape. This, it seems to me, would be an improvement on his method, as it would simplify laying out the former, particularly in the case of work having curved outlines other than arcs of circles, besides doing away with the wire ropes overhead, which might be an objection in case the work was very wide, and necessitated considerable travel of the saddle on the cross rail. The only objection to the method here advocated is that the tool would not be fed positively to the work, but would only take as much of a cut as the holding down weight would induce it to.

WALTER GRIBBEN.

[The drawing on page 460 was not supposed to be to scale but merely to indicate the method.—ED.]

Sectional Jig Bushing

An attempted criticism of my article, A Sectional Jig Bushing, appeared on page 457, the writer claiming to accomplish the same ends by a much simpler route.

Proximity of the drilled holes, alone considered, Mr. Haessler's way admittedly suffices; but from the viewpoint of accuracy, his method is hopelessly inadequate.

Describing his first operation my critic naively observes that the work is "carefully centered;" though by what method he is assured of accuracy to 0.0001 inch he carefully conceals. He then adds that with care there is no difficulty in starting the drill true. Another probable source of error!

My friend then proceeds to beg the question entirely by assuming that a drill 0.040 inch diameter will keep unswervingly true through 0.5 inch of stock. Every toolmaker knows that such a drill will deviate more or less from its true direction in ninety-nine cases out of a hundred. Indeed it was from this consideration alone that the scheme was devised affording free access to all four sides of each part after being drilled and harden, thus insuring accuracy.

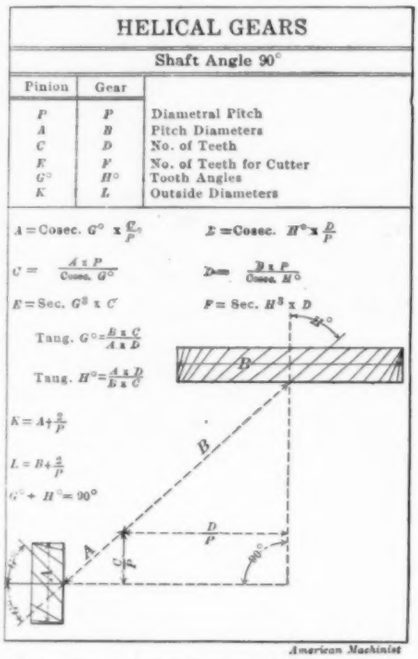
Mr. Haessler's idea of precision, however, is humorously revealed in what he describes as "ocular proof," which for definiteness reminds one of the inevitable "pinch of salt" alluded to in a housewife's cookbook. It would be presumption on my part to consider that my device is the only one that can be conceived to overcome the difficulty under consideration, but I do not claim that if another method guaranteeing accuracy exists, Mr. Haessler has failed to present it.

Middletown, Conn. ELI ALLISON.

Direct Solution of Spiral Gears

I was very much interested in the article on page 432, on "Direct Solution of Spiral Gear Angles," and with to add my quota to the information on the subject.

Nothing new is claimed for the principle I am about to show, as it was described in AMERICAN MACHINIST several years ago, but the data sheet, which I inclose, shows my method of handling the problem. The old saying, "Mother love is blind," applies here as well as in other things, for we all think our way is the best and simplest, due to having worked it out and therefore understanding the procedure thoroughly. I am no exception to the rule and would like to have your



GRAPHICAL SOLUTION OF SPIRAL GEAR ANGLES

readers test my method, which needs no tables and therefore can be used at a moment's notice, in the shop or elsewhere. The only tools required are a flat surface, scale, pencil or scriber and a protractor.

The pitch, ratio and center distance being known, the first step is to draw a horizontal line and then one perpendicular to it at its extremity. Next form a rectangle by the addition of two lines which are equal to the length the pitch diameters would be if the gears were regular spurs. Three are represented by $\frac{C}{P}$ and $\frac{D}{P}$ in the data sheet.

As the sum of the pitch diameter equals twice the center distance, $A + B =$ center distance $\times 2$. The next step is to set the scale on the layout, so that it intersects the point of the rectangle, and swing it around until the distance $A + B$ is correct, or twice the center distance. Two angles will be found to give the correct result, one 45 degrees +, and 45 degrees —; either can be used.

If it is found impossible to locate line $A + B$ so as to have it the correct length, and at the same time intersect the point of the rectangle, it shows that the number of teeth in gears is not correct for the conditions. If the line is too long, the number of teeth in the gears is too great; and if the line is too short, there are not enough teeth.

The formulas can now be used to check the work if desired, but their principal use is for conditions where the center distance is not fixed and the tooth angle is 45 degrees.

This data sheet has been used for several years, and so far as I have any knowledge, with complete satisfaction to all concerned.

New York City. F. W. H.

Air Cooled Emery Wheels

After reading Mr. Sawtell's article on page 460, Volume 33, Part 2, I am of the impression that he misunderstood my statements concerning air-cooled emery wheels.* I referred to the 46 grade N alundum wheel merely as an illustration, and further stated that if he would put his troubles up to the wheelmakers he would find it unnecessary to cut air-cooling notches in the wheels. The writer has had considerable experience on work similar to that mentioned by Mr. Sawtell, and used a wheel 200 grade 3 elastic, thus eliminating the necessity of cutting air-cooling notches in the wheel.

Boston, Mass. S. H. MERRILL.

A hydroelectric power house is to be erected on the west side of Green island on the Hudson river, the capacity of which will be about 6000 horsepower. This power will be available not only for the present industries on the Troy side of the Hudson river, but will also offer exceptional advantages to other industries both in Troy and Green island, which at present use purely hydraulic power. The amount of electrical energy thus generated will, in fact, be equivalent to a threefold increase compared with the present hydraulic supply. Electrical energy will be sold to consumers by the Government at the cost of production, or about a third of the cost of the power generated at Niagara Falls. It is mentioned, however, that it will be necessary for the companies using the power to meet the cost of constructing the power house.

A good waterproof glue is made as follows: 1 part of india rubber, 12 parts mineral naphtha or coal tar, heat these gently, mix them and add 20 parts of powdered shellac. Pour out on a slab to cool; when used to be heated to 250 degrees.

Tools in a Turret Machine Shop

Editorial Correspondence

Devices for facilitating the babbitting of heads, the boring of bearings for the spindles and the preparation of turrets for reception of the hardened and ground steel bushings which admit locking bolt.

How the work is handled in different operations for securing the desired results.

A few operations recently noticed by a visitor in the shops of the Acme Machine Tool Company, Cincinnati, Ohio, are illustrated by the accompanying engravings.

A Babbitting Outfit

The turret lathes and screw machines built by this company are provided with babbitted bearings for the spindles, and the method of rigging up for pouring the boxes is represented in Fig. 1, which shows the shape of the babbitting mandrel and the manner in which it is supported and located correctly by fixtures at either end. The cap is lifted from the front bearing to illustrate the method of producing the annular channel for the ring oiler by means of which the spindle bearings are kept thoroughly lubricated.

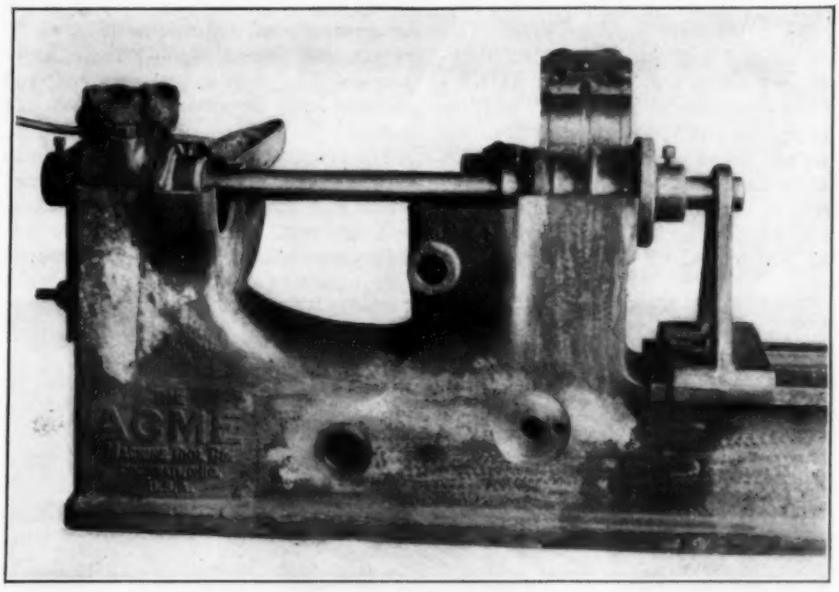


Fig. 1. Babbitting Arbor for Turret Machine

The collar which forms the oil chamber is part of the flanged sleeve on the mandrel, and a similar collar is formed at the other end for the channel in the rear box. The outer flange is adjustable to suit the end of the head and the device is readily placed in position for the pouring of the metal. Both the cap and the head are cast with dovetail lands and grooves to anchor the metal securely in place. Two holes are drilled through the caps for the admission of the molten metal. Clay is applied in the manner indicated prior to the pouring operation.

After the boxes are poured and the caps removed the metal is thoroughly compressed by peening and is then ready for boring.

Boring on the Horizontal Machine

Fig. 2 shows a 1½x9x17-inch swing screw machine in place on a Lucas horizontal boring machine, with a cutter bar in operation in the bearings for the spindle. Prior to the boring operation the bearing surfaces on the screw-machine bed have been machined and scraped so that it may be placed properly in the boring fixture. As represented, the work is held upside down, resting upon the ways and the same fixture carries guide bushings for the boring bar, which is driven by means of a universal connection from the spindle of the boring machine.

The boring bar carries two single-end cutters spaced the correct distance apart to permit them to operate simultaneously at the two ends of the head. Two cuts are taken through the bearings, the finishing cut being a very light one with the cutter bar fed quite rapidly so that a scraping chip is taken. The bearings in the casting shown are bored out to 3 inches and 2⅝ inches respectively.

In addition to the operation illustrated, the same machine and fixture are employed for boring the back-gear shaft bearings and the holes at the end of the head for attaching the feed bracket.

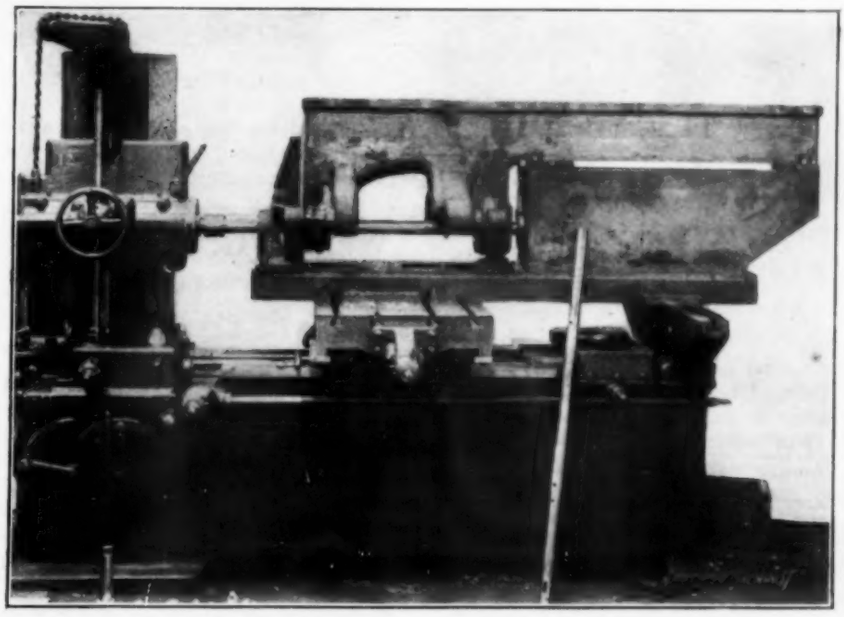


Fig. 2. Boring the Head for the Spindle Bearings

A Turret Drilling Jig

The turrets of these machines are provided with hardened and ground taper bushings let into the bottom face near the periphery, for the reception of the locking bolt. The seats for these bushings are bored and reamed by means of the jig illustrated in Fig. 3, which is shown in use under the radial drill. The jig is located on a finished bearing surface around the cylindrical hub of the turret, and its position in relation to the turret flats is determined by a line scribed on the face of the small boss shown plainly

in front of the jig, this line coinciding with a line scribed on the center of one of the flat faces of the turret. The work and jig are clamped down on the table by a through bolt with a nut at the top.

The first operation with this jig is to drill a hole slightly deeper than required

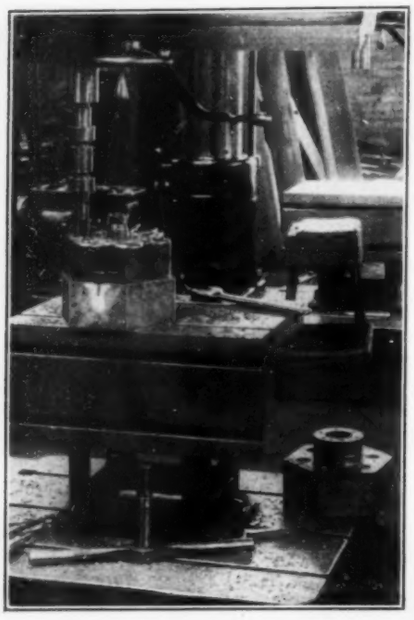


FIG. 3. BORING HOLES IN TURRETS UNDER THE RADIAL DRILL

for the locking bolt bushing, then with the counterbore shown in operation the hole is enlarged nearly to the required size, after which the hand reamer shown on the base of the drill press is run in to size the hole. The tool shown in the jig for enlarging the hole is not piloted at the bottom as in the case of a regular counterbore, but instead, it is guided by an enlarged portion on its shank, which

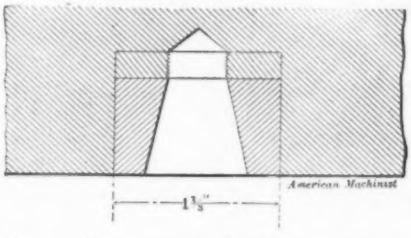


FIG. 4. TURRET-LOCKING BUSHING WITH WASHER SEAT

fits nicely in the long jig bushing, the drive from the spindle being by means of a form of universal joint. Similarly the reamer is guided by a cylindrical body back of the cutting blades.

An interesting feature in connection with the locking bushings in this form of turret is illustrated by the sketch, Fig. 4. Here, as will be noticed the inserted bushing is seated against a steel washer which is tapped so that in the case of its ever becoming necessary to remove the bushing for any purpose, a bolt or screw may be run down through the washer to press the bushing from its seat.

FORMING HANDLES

Fig. 5 shows one of the 2¼x11-inch screw machines set up for machining handles, which are later fitted into the arms of pilot wheels of the turret machines. The handle being machined has a hole drilled and reamed in the outer end, and during the forming operation, which is accomplished by a broad flat tool in the front block, it is supported by a pilot extending from the turret. Where such handles are formed with a straight neck instead of a hollow end, the outer end is turned with a tool like that which is shown attached to the turret and projecting to the right over the slide. This is a turning tool with two roller backrest jaws which may be readily adjusted by the nurled-head screws. While the turning tool and the working ends of the jaws are not shown it will be understood that tool and rests are so positioned relatively to one another as to support the work steadily under the action of the cut. The cutting-off tool, as represented,

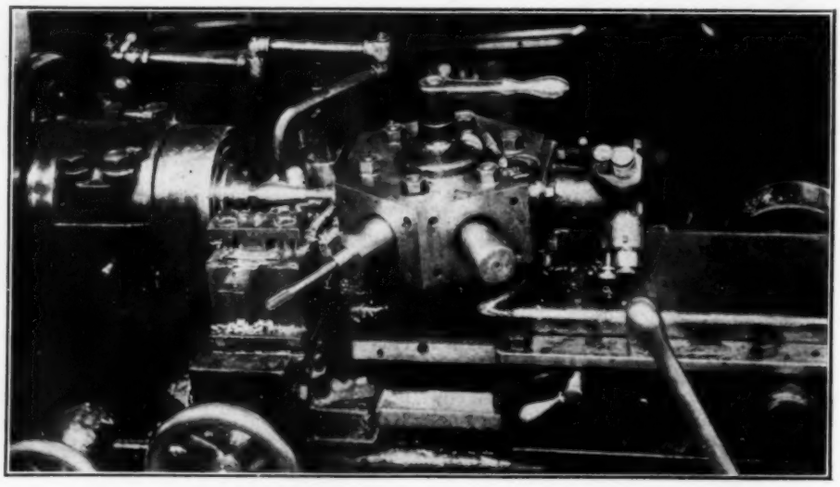


FIG. 5. FORMING HANDLES ON THE TURRET MACHINE

is carried at the rear of the cross slide and is inverted so that the spindle is not reversed for the severing of the work.

Why the Gears Were Inaccurate

BY HENRY GRAY

Accurate work cannot be done on a machine unless all conditions surrounding the job in question are accurate. The criticism leveled at manufacturers on account of spoiled work can be attributed more often to the carelessness of a workman in the setting up of work than to poor workmanship or faulty design, as critics would have us believe.

Statements similar to the above were made in my hearing recently by a member of a prominent milling-machine firm. This company had just received from Europe a dividing head of their manufacture and two accompanying gear blanks which the customer said were not spaced accurately.

And they were inaccurate too, for he showed me the two blanks mounted on an arbor; and when one was twisted a quarter way round, the variation in the spacing was very noticeable.

"But," he added forcibly, "I knew well enough the head was accurate and proved it in this way."

The same head was given to a careful workman who was told to cut a certain number of teeth in three sets of blanks of two each. The first set were to be cut as accurately as the dividing head would permit, the second set with the arbor dropped 0.002 inch at the outer end, and the third with the arbor 0.005 inch out of line.

The result of the test was as the manufacturer had predicted. The first set, which was cut as accurately as possible, was accurate. The other two were not. Of course the error in the blanks dropped 0.005 inch was greater than that of the 0.002 inch out of line. But even in the latter case it was sufficient to cause trouble in work requiring accuracy.

"And the upshot of the whole affair," he said, as he walked on, "was a whole lot of correspondence and a strong likelihood of ill feeling for nothi .g for which we were to blame."

Much has been said regarding the number of automobiles required to fill the normal and legitimate demand from year to year. Some have claimed an output of over 200,000 cars for this year and considered it a fair average demand. But H. H. Franklin, builder of the Franklin car, considers that next year's output will not be over one-third of claims for this year and that the 1910 output will not be exceeded for many years.

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American Machinist

Editorial

Needed—A Study of Distribution

We have men today who are experts in financing manufacturing operations—we have many men who are experts in production—but have we many experts in distribution? This implies a knowledge of distribution in the widest possible sense—a complete and intimate acquaintance with the existing world's markets, a knowledge of prospective markets, and above all a clear understanding of the world wide economic conditions that lie as the basis of all successful trade.

Such an expert in distribution will not believe that the markets of the United States are sufficient for his firm, but he will demand that his firm shall receive their just proportion of the trade of the entire world. Furthermore, he will not look upon a foreign market as a place to dump a surplus of machinery, especially in periods of panics or hard times, but will realize that a foreign market must be assiduously and systematically cultivated and worked, year by year, month by month, in fact, day by day, for such a course is the only one which can build up a successful, permanent foreign trade.

So much has been written for American manufacturers along the lines of possible foreign business that it has gotten to be a hackneyed subject. Nevertheless, it is of extreme importance, for if American manufacturers do not reach out for these world markets we may rest assured that other nations will, and the motive for so doing is stronger with some of them than with us, for the reason that their home markets are more limited.

What is needed is a more careful study of distribution, a study that will lead to a continuous cultivation of all foreign markets. If this is not done, America will finally become a land of splendid trade isolation.

The Future of Aerial Navigation

The repeated accidents with flying machines of both the aëroplane and the dirigible types, culminating in the disaster to the Zeppelin VI, lead inevitably to serious consideration of the future of aërial navigation, and the first conclusion to which one comes is that, in spite of the wonderful technical progress that has been made, but little has been done toward surmounting the inherent dangers.

Of these two types the dirigible balloon would seem to be essentially far safer, but nevertheless we find that five Zeppelin airships have been destroyed in succession, and this in spite of an engineering skill in the construction which has scarcely been surpassed in any structure of any character. The latest disaster is described as due to an explosion of the motor, danger of which would seem capable of elimination, but three of the former vessels were destroyed by that most common of the events of nature, a gale of wind against which it seems hopeless for such structures to contend.

The use of an airship as an engine of war, especially in scouting work, has seemed to be the one about which there could be no question; but in this very field it has scored a failure which is nothing less than ludicrous, having completely misled a commanding officer in the recent army manœuvers in eastern Germany.

The AMERICAN MACHINIST was one of the first papers to hail the achievements of the Wright brothers as epoch making in their importance, and we abate nothing of our admiration for their work. From the commercial point of view, however, even assuming that the use of gyroscopes or other devices will eventually render it comparable with an ocean liner in stability, the uneconomic use of power is a serious drawback to its development. Until the power consumption can be reduced to somewhere near that used for land transportation at the same speed, it will not become a factor in the field now occupied by the locomotive or the automobile.

It is probably capable of greater speed than any form of land transportation, which puts it in a class by itself for certain uses, such as army scouting and possibly offensive attack when we have become more skilled in its operation, but much remains to be done before it can be called a commercial vehicle in any sense.

Finding Men Quickly

One of the little leaks that creep in almost unnoticed, is the time lost in locating the man you want in the shop.

In these days of ever increasing use of the telephone, any official from a foreman

up, is likely to be called to the 'phone on important business. The time lost in finding a boy to send out in the shop and getting him in to the 'phone, not only counts in dollars and cents but it seems twice as long as it really is to the waiting customer.

Interior telephones have come to be necessities and there are two general methods for locating men in any part of the shop. One is a system on colored electric lights, a distinct color for each man, which is lighted in every department in the shop by the telephone operator. The other and perhaps simpler system, is the ringing of a gong with a predetermined number for each man.

This can also be done by the telephone operator or by anyone else and the insistent ringing of a gong is sure to attract attention fully as much as the lights in most cases.

But the method is not nearly as important as the adoption of some way of finding men quickly, both for the saving in time and the satisfaction of the waiting ones.

Strength of Timber

There has been a suspicion for some time that the strength values for timber as commonly given in text books and engineering handbooks are considerably too high. This suspicion has been strengthened by a series of timber tests recently concluded at the experiment station of the University of Illinois; all of these tests gave much lower strength values than those commonly cited from books.

This indicates that a word of warning is opportune to those who deal with timber as a material of construction. Either the strength values commonly used should be revised, or factors of safety should be increased.

An additional reason for greater care in calculations having to do with the strength of timber is the fact that as our supply is decreasing the quality is necessarily deteriorating. From time to time inspection requirements have been reduced during the last few years, with the result that sticks are now passed as merchantable timber that a few years ago would have been rejected. Thus sticks may now contain knots, shakes, checks and cross grain to such an extent as to seriously weaken them, and when such sticks are put into a structure alongside of sound timber their deflection under a small amount of load will tend to throw a disproportionate amount of load upon the sounder sticks, with the possibility of serious weakening to the entire structure.

It is gratifying to note the experimental work that is being done in connection with timber and the interest that the subject has aroused. For this work will soon give us a mass of experimental data from which we can revise our factors.

Cooperative Education at Providence

The coöperative plan of industrial education has been formally inaugurated at Providence, R. I., 16 boys having joined the first class.

The plan of the work is very similar to that followed at Fitchburg, Mass. It includes four years of work in the high school, the first being given entirely to the school work, while the remaining three years are divided between the school and the shops on the plan with which our readers are now familiar. The boys are tried out by a three-months' term of service in the shops, this term occupying the summer vacation following his first year of high-school work. Those who complete the trying-out term successfully become regular apprentices and sign formal apprenticeship papers. The new class of 16 boys is the residue of a total of 26, who have been thus tried out during the past summer.

The school work is to be only partly technical, although it will all have an industrial value. As now laid out, the course of study will include industrial history, including the development of hand work, the introduction of machinery, the apprentice system, and the development of labor organizations, American history, commercial geography, bookkeeping, shop accounts, and other business methods, and mechanism or advanced physics.

The school work is in charge of Russell C. Lowell, who, as president of the Providence Association of Mechanical Engineers, is largely responsible for the agitation which has resulted in the adoption of the plan.

In the formal organization of the plan, an agreement was executed between the school authorities and the manufacturers of Providence, these manufacturers at present including only those engaged in the machine-building industries. It is expected that, as time goes on and experience justifies, the scope of the work will be extended to include all of the leading industries of the city.

New Publications

Composition and Heat Treatment of Steel, by E. F. Lake. 252 6x9-inch pages, with 143 illustrations. The McGraw-Hill Book Company, New York and London. Price $2.50.

Mr. Lake's name and work are so familiar to our readers as to lead them to know what to expect in a book on steel from his pen. After some preliminary chapters on the processes by which steel is made, he gets down to brass tacks in a chapter on Ingredients of and Materials Used in Steel, in which the materials entering into the composition of the modern alloy steels and their effects are discussed. Next comes a chapter on the methods of working steel into shape, and following this are chapters on furnaces and tools used for heat treatment, annealing, hardening, tempering and carbonizing steel. All of these contain a wealth of strictly uptodate information, some of which is not obtainable elsewhere, and little of it except through scattered articles in this and other publications. It is not too much to say that the intelligent steel worker will find here most of the information which he wants and of the kind which it is possible to put into print, and that it is a rare steel worker indeed who will fail to find many things which to him are interesting, useful and new.

National Machine Tool Builders' Association

The semi-annual convention of the National Machine Tool Builders' Association is to be held at the Hotel Astor, New York City, October 25 and 26.

In addition to the regular business and reports of standing committees, the following program of subjects has been arranged for discussion:

"Who Should Pay the Expenses of a Representative from the Factory when Sent Out at Request of the Dealer to Help Close a Deal?" By F. L. Eberhardt and C. H. Norton.

"The Use of Ball or Roller Bearings in Machine Tool Construction." By Henry Hess.

"Advertising—Large Space in a Few Papers vs. Small Space in a Number of Papers." By Thomas H. Moore.

"Concrete vs. Wood Flooring." By James N. Heald.

"Design and Construction of Machine Tools from the User's Standpoint." By C. K. Lassiter and John Riddell.

Personals*

M. A. Coolidge, president of the Fitchburg Machine Works, sailed for a six weeks' European trip on October 18.

John Bath, of the Bath Grinder Company, Fitchburg, Mass., sailed for Europe on October 18 and expects to remain abroad six weeks.

T. H. C. Hansen, who has been superintendent of the Chicago Brass Company, Kenosha, Wis., has become associated with the Wire Specialty Works, Chicago, Ill., and will act as superintendent.

Joseph P. Kirkup, who has been manager of the Philadelphia office of the L. J. Wing Manufacturing Company, has been recently transferred to the engineering department of the New York headquarters of that firm.

*Items for this column are solicited.

Wheels for Vertical Surface Grinding

By James O. Smith*

Grinding broad surfaces with a vertical machine imposes different conditions on the abrasive wheel from any other form of grinding and requires a special wheel for best results.

These suggestions give the result of much experience in the selection of the best wheels for such work and are well worth careful consideration.

This machine represents new features in grinding, some of which are not generally understood, and on this account, many operators have trouble when first using it. This is because the right grade of wheel is not selected and because proper care is not exercised in mounting and operating the wheels. On this account the operator fails to secure the high degree of efficiency of which this machine is capable, the wheel either heats the work or wears away very rapidly, and in many cases is broken in use.

The standard wheel for the Pratt & Whitney vertical grinder is cup shaped, 12 inches in diameter, 4-inch face, with 1¼-inch rims and 8⅜-inch holes. On account of the relatively large surface of contact between the wheel and the work, and because there is not the same clearance as in other forms of grinding, unusually soft wheels are necessary. And soft wheels (containing less "bond" or binder) are not as strong as wheels of harder grades. For the same reasons the utmost nicety of grading is required, as a wheel on this grinder if only slightly too soft will wear rapidly, while a wheel only slightly too hard will fill and glaze.

Handle Carefully

When due care is taken there is no danger of the wheels breaking. The wheels should be handled carefully and not subjected to any blow or jar. The wheels have a ½-inch back, and are held in the holder by a brass ring. Shellac is also applied to the back of the wheel and when mounting, the shellac between the wheel and the holder must be applied evenly so that the wheel may not be thrown out of alinement. The ring should be tightened evenly and snugly, but gently. I have seen these wheels broken by tightening the ring too tight and also by operators applying sudden heat to the wheel, thinking to make the shellac "soak in" better. This is wrong. Grinding wheels are poor conductors of heat and sudden application of heat will start cracks. If you must heat them, warm them gradually.

These wheels should not be run more than 1100 revolutions per minute. Many operators attempt to use too heavy a feed. On steel or cast iron 0.002 inch is enough. On softer metals a heavier cut can be taken if the surface is not too large.

A very important point to be observed is that there must be no vibration in the wheel spindle or in the floor on which the machine stands. If there is, you will have trouble, with breakage of wheels.

Suitable Grains and Grades

The following grains and grades have been found to be the best adapted for the various operations in question. The grains and grades given are those of the American Emery Wheel Works, Providence, R. I.

For Soft Steel	No. 24 corundum, grade	1½
For Hardened Steel	No. 30 corundum, grade	½ to ¾
For High Speed Steel	No. 24 corundum, grade	½
For Wrought Iron	No. 24 corundum, grade	1½
For thin pieces of High Speed Steel	No. 30 corundum, grade	H
For Cast Iron	No. 24 carbo, grade	J to L
For Chilled Cast Iron	No. 24 carbo, grade	H to I
For Malleable Iron	No. 24 carbo, grade	J
For Aluminum and Bronze	No. 24 carbo, grade	K

The Corundum wheels are made by the silicate process (except the 30-H), while the Carbo wheels are made by the vitrified process.

If the surfaces to be ground are very large, slightly softer wheels than those recommended will be better, while if the surfaces are very narrow, so that the operation becomes practically edge work, somewhat harder wheels must be used for best results.

Magnetic chucks are quite generally used on these grinders. I found one operator who had trouble on account of the electric current being shut off in the plant (and, of course, from his chuck) while he was grinding, with the result that his work (if small) flew in all directions, doing considerable damage and spoiling the work. Now he has an electric bell beside the grinder connected with the engine room and the electrician notifies him in advance before shutting off the current, giving him time to stop his machine.

*Domestic sales manager, American Emery Wheel Works, Providence, R. I.

Gearing for Automobiles

By Charles H. Logue.

About the greatest single source of annoyance to both automobile builders and users—especially the latter—is the speed-change gears which are in a case carried between the motor and the rear axle. These gears and case form an additional weight to the car and are often placed at the point of least advantage, and aside from eating up a large percentage of the power generated by the motor, owing to the necessary distance between bearings; poor fit of the gears on the keyed or square shafts and poor alinement, the teeth are difficult to engage, being rapidly destroyed by the necessity of sliding them into mesh.

Who has not had his teeth set on edge by the slur of the engaging gears as the speed is changed, even when the car is in charge of a careful driver, and in the hands of a careless driver the noise and consequent wear are excessive.

Again, the hardness best suited to resist the hammering action of the spur change-gear teeth entering contact is not the best for long life when the wear of the gear is considered.

The bevel gears on the rear axle are constantly in mesh and may, therefore, be hardened to secure the longest possible life from a standpoint of wear alone. It must be admitted that the spur-gear drive is superior to a bevel-gear drive, but as the bevel gear is indispensable, owing to the position of the motor, therefore would it not seem best to transmit the power direct to the rear axle, without carrying it through the change gears?

According to a consular report an ambitious attempt at real aërial navigation by a Scotch inventor is in progress, in the construction of a flying machine to weigh about six tons and designed to carry 20 to 30 passengers. When complete the machine will cost about $50,000. It is a little more than half completed at present. The machine in shape bears resemblance to a bird and embodies the rotary-wing theory of flight. For each wing will be a large gyroscope or fan 27½ feet in diameter, revolving horizontally, like inverted basins. The rotary wings with their horizontal movement will, it is claimed, enable the machine to travel in any kind of weather and by its own power raise itself vertically from the ground. It is said the invention is in advance of anything already constructed. Aviators and experts, however, express considerable doubt as to the success of the advanced improvement and question whether a machine weighing so much can lift itself from the ground or prove a decided success in other ways.

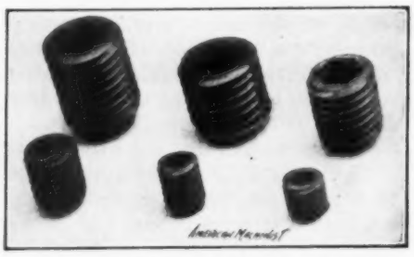
New Tools and Shop Appliances

Allen's Safety Set Screws

The halftone shows some new set screws which are being put on the market by the Allen Manufacturing Company, Inc., 135 Sheldon street, Hartford, Conn.

These set screws are made from round bar stock with the various points, cup, conical, oval, dog and flat. They have a hexagonal hole formed in one end for the wrench, which can readily be made by bending a piece of hexagonal steel of the right size at right angles. The point of the screw is heavily reinforced, so as to resist any tendency to crush under heavy strains, for instance, the ¼-inch set screw 1 inch long, has ⅜ inch of steel between the bottom of the hexagonal wrench hole and the point.

In use these set screws are entirely within the hole they fit, there being no projection to catch on clothing, etc., and cause accidents.



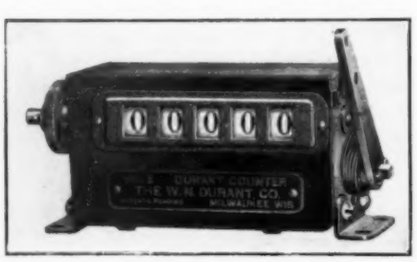
ALLEN'S SAFETY SET SCREWS

A Counter

The new Model B counter illustrated is similar in size and appearance to the standard Model B made by the same concern, but is fitted with a large thumb nut at left of the case, a single turn of which will bring all the figures instantly to 0 from any point. Wherever quick resetting is desirable this machine fills the need.

These counters are compact, have large prominent figures and are inclosed in a neat, small case. The working parts are few and the digit wheels full geared. The driving ratchet is of a special type affording a very short stroke if desired and rendering skipping or jumping absolutely impossible even at high speed.

These counters are also made with rotating shaft, with star wheel, lineal measuring wheel, etc., both with and without the instantaneous resetting feature, by the the W. N. Durant Company, Milwaukee, Wis.



DURANT MODEL B COUNTER

A Four Head Drilling and Turning Machine

Fig. 1 shows a new design of the Garvin four-head drilling and turning machine, rigged for turning drop-forged crosses, as used in automobile manufacture. The box tool with three or more tools, is screwed on the end of the spindle, and will turn one or more diam-

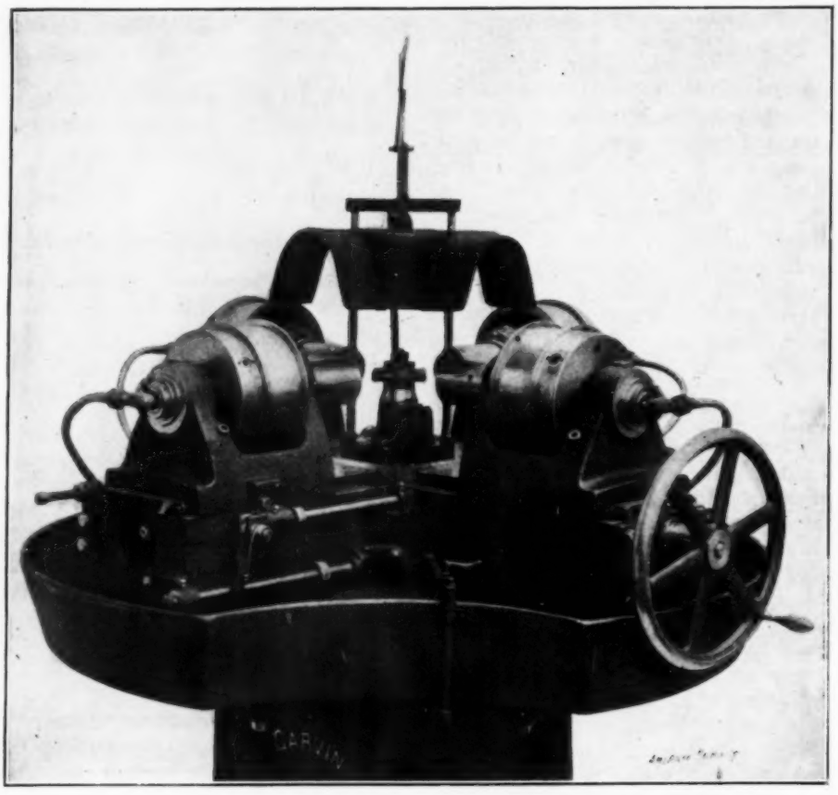


FIG. 1. FOUR-HEAD GARVIN DRILLING AND TURNING MACHINE

FIG. 2. THE FIXTURES AND WORK

eters, giving them a highly burnished finish, and finish the shouldered ends up to an accurate gaged distance. The lubricating oil is fed under pressure through the spindles, thus eliminating all chip troubles, and to confine the oil and chips, a balanced hood is arranged to cover the work, which is readily lifted to allow for the putting in and taking out of work.

Fig. 2 shows various styles of fixtures and classes of work that are done on the machine. These pieces are all four positioned pieces, but by using an index fixture, the drilling and turning of pieces having eight, twelve or more positions can be accommodated.

The extreme distance between the ends of the spindles is 16 inches, with a travel of 6 inches to each head, which brings the spindles within 4 inches of one another, thus allowing of the drilling of holes 6 inches deep with each head, and also of the finish turning of work 3 inches on each end of pieces 10 inches over all. Shipping weight 3250 pounds. The maker is the Garvin Machine Company, New York City.

A Patternmaker's Band Saw

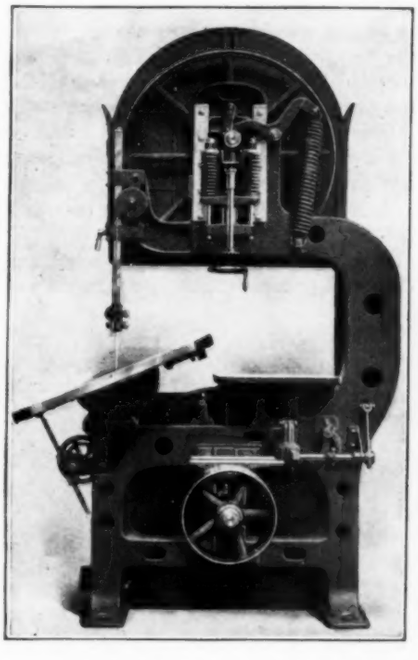
The halftones show a band-sawing machine, built by P. Pryibil, New York.

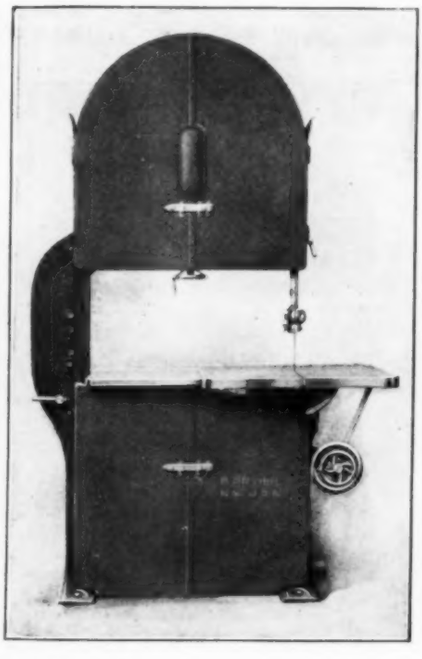
The machine, known as No. 7, will take blades up to two inches wide. The frame is cast in one piece. The table is of cast iron, and the throat through which the saw passes is in the form of a disk, which is easily removed when its wooden lining requires renewing.

The table tilts to the right to any angle up to 45 degrees, and to the left to 5 degrees.

The wheels are cast iron, turned inside and outside and are in running balance. Their rubber faces are vulcanized in place. The lower wheel is extra heavy and acts as a flywheel.

The mechanism is entirely inclosed on the working side of the machine and the slack side of the saw runs in a cast-iron channel, which protects the operator from coming in contact with it, and also prevents it being thrown off the wheels by being struck accidentally.





A Patternmaker's Band Saw

Schmaltz Twist Drill Grinders

The accompanying illustrations show two sizes of the automatic twist-drill grinding machine built by Friedrich Schmaltz, G.m.b.H., Offenbach am Main, Germany. They are full automatic, rigid and copiously water cooled. The abrasive wheel is broad and the builders state that 40 or more unclassified drills can be ground per hour, an unskilled workman being able to attend to two or three such machines at the same time. Special emphasis is laid upon the correct centering of the drill point, with the desired cutting angle, grinding of the lips to regular length and provision of any relief that is wanted. The adjustment of cutting angle and relief can be made while the machine is running. The feed against the wheel is automatic.

The grinder will handle all sorts of twist drills, whether cylindrical or conical, and with thicker or thinner tangs, centering them in a simple precision chuck which is the most important part of the machine. In this chuck the work is thrust forward by a helical spring, of which there are different lengths for drills of sufficiently differing lengths. For chucking and examination of the work, the head is readily moved away from the wheel by a hand lever and returned. To promote regularity in wear of the wheel, it is made to travel back and forth axially while at work. A truing fixture is placed behind the guard. There is a countershaft on the machine for belt driving or an electric motor is attached. For thinning the point of the drill there is a simple device easily operated from the workman's standpoint, but, if desired, a more complicated fixture can be provided for this purpose.

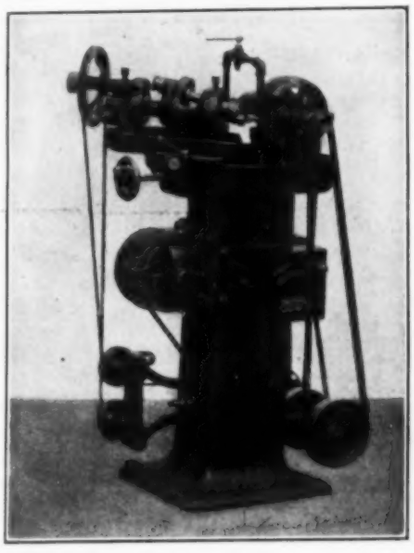


Fig. 1. Schmaltz Twist-drill Grinder, Small Size

These grinders are built in three sizes, the smallest of which, Fig. 1, is intended for drills from 0.08 to 0.6 inch diameter and has a wheel 6x0.8 inches. The largest size, Fig. 2, is for drills from 1.2 to 3.2 inches diameter, its wheel being 20x 2.6 inches.

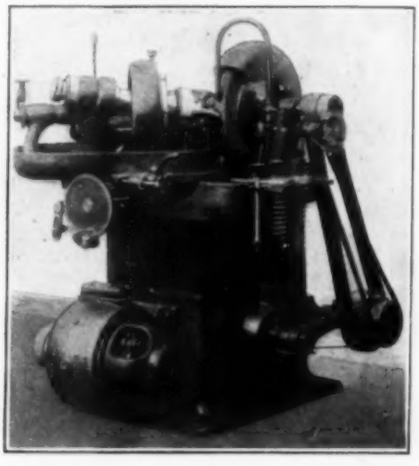


Fig. 2. Schmaltz Twist-drill Grinder, Large Size

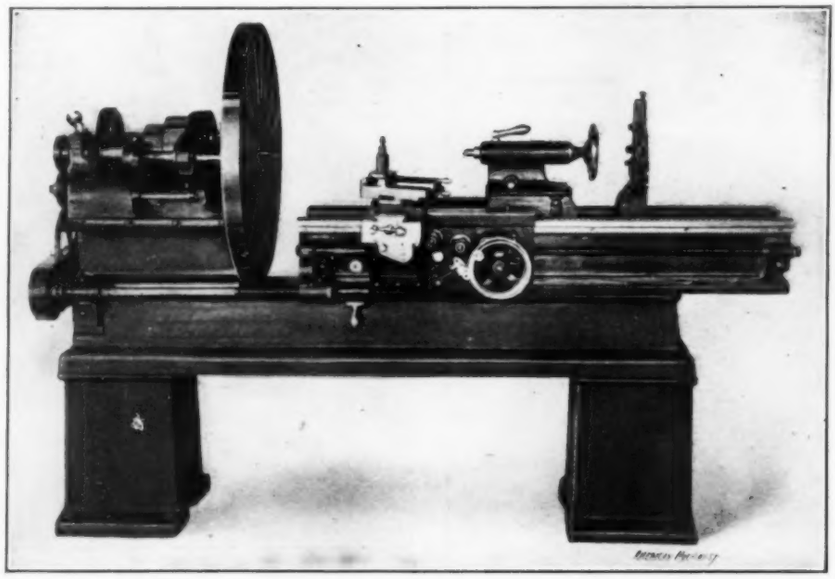
The Oneida Steel Pulleys

The halftones show a steel pulley, built by the Oneida Steel Pulley Company, Oneida, N. Y. These pulleys are made in sizes from 6 to 126 inches diameter, with faces from 2 to 40 inches in width, and to fit any standard shaft from 1 to 8 inches diameter. In pulleys with extra widths of face, extra sets of arms or spiders are inserted, one set for each 8 inches of width; for instance, a pulley having 40 inches face would have five sets of spiders. By means of a system of interchangeable cast-iron bushings, a pulley may readily be fitted to any one of several different sizes of shafting. No keys or set-screws are necessary with these pulleys, the bolts at the hub being sufficient for clamping. The arms are reinforced at the rims by an extra thickness of plate riveted to arm and rim.

An Extension Gap Lathe

The halftone shows a 14x28-inch extension gap engine lathe built by Fay & Scott, Dexter, Maine.

This lathe follows out the same general lines as the other sizes of this lathe. Several features have been added to this size lathe, however. One is, that the upper bed moves by power instead of the hand feed screw on the back. Power is applied by means of a small handle which is shown hanging down about midway of the lathe, the handle being attached to a half nut which is lifted up into mesh with the thread on the feed rod, thus transmitting the power for moving the upper bed. The bracket for supporting the overhanging carriage used in connection with the full swing diameter in the gap, is supported by a bracket having a bearing against the apron, the apron having a support against the upper bed with an adjustable gib.



AN EXTENSION GAP LATHE

A Machine for Rolling the Teeth into Gear Blanks

The illustrations show a machine which has been invented by Harold N. Anderson, mechanical engineer, Speedwell Motor Car Company, Dayton, Ohio.

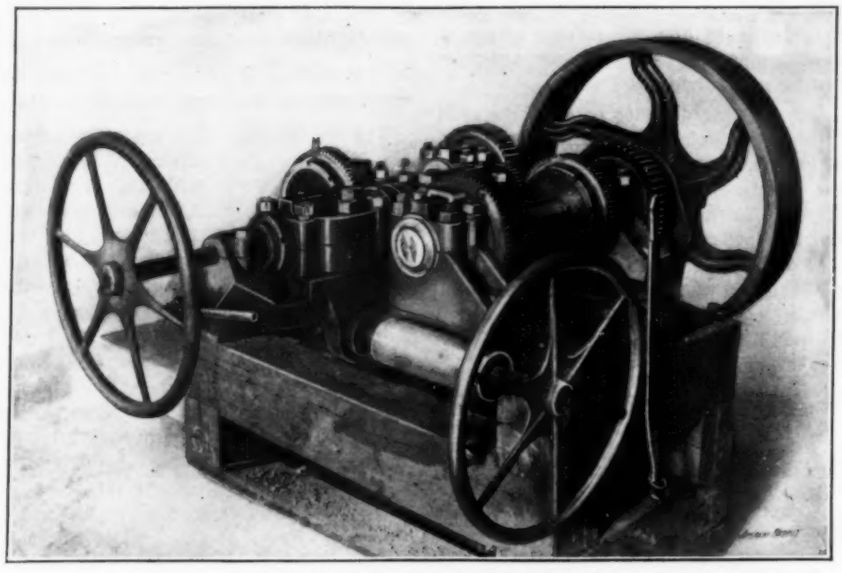


FIG. 1. THE GEAR-ROLLING MACHINE

The machine rolls the teeth in steel spur-gear blanks. Since the photograph was taken, from which Fig. 1 was reproduced, the pulley at the back has been replaced by a gear driven by a pinion.

Fig. 3 shows a pair of 6-8-pitch gears rolled on the machine. The one to the right has the fin trimmed off all around the rim, while the one to the left has the fin left on, with the exception of the five teeth next to the other gear.

This method of manufacture is said to make the metal in the teeth very dense and hard.

A machine for rolling bevel gears is being developed by the inventor.

The halftone, Fig. 1, shows a general view of the machine and Fig. 2 a plan and elevation.

Referring to Fig. 2, *A* is a bed plate on which bearings *B* and *C* are mounted. The shaft *D*, journaled in these bearings, carries the gears *E* and *F* and the finishing roller *G*, all keyed thereon. An adjustable plate *H* carries the bearings *I* and *J* and shaft *K*, on which is keyed the gear *L* and the breaking-down roller *M*. Bolts secure the bearings to the plate *H*, and the plate *H* to the base *A*. A feather on the plate fits in a groove in the base *A* and insures proper alinement of the shaft *K*. An idler gear, *N*, connects the two shafts. This gear rotates on a bush secured by a link so as to maintain a

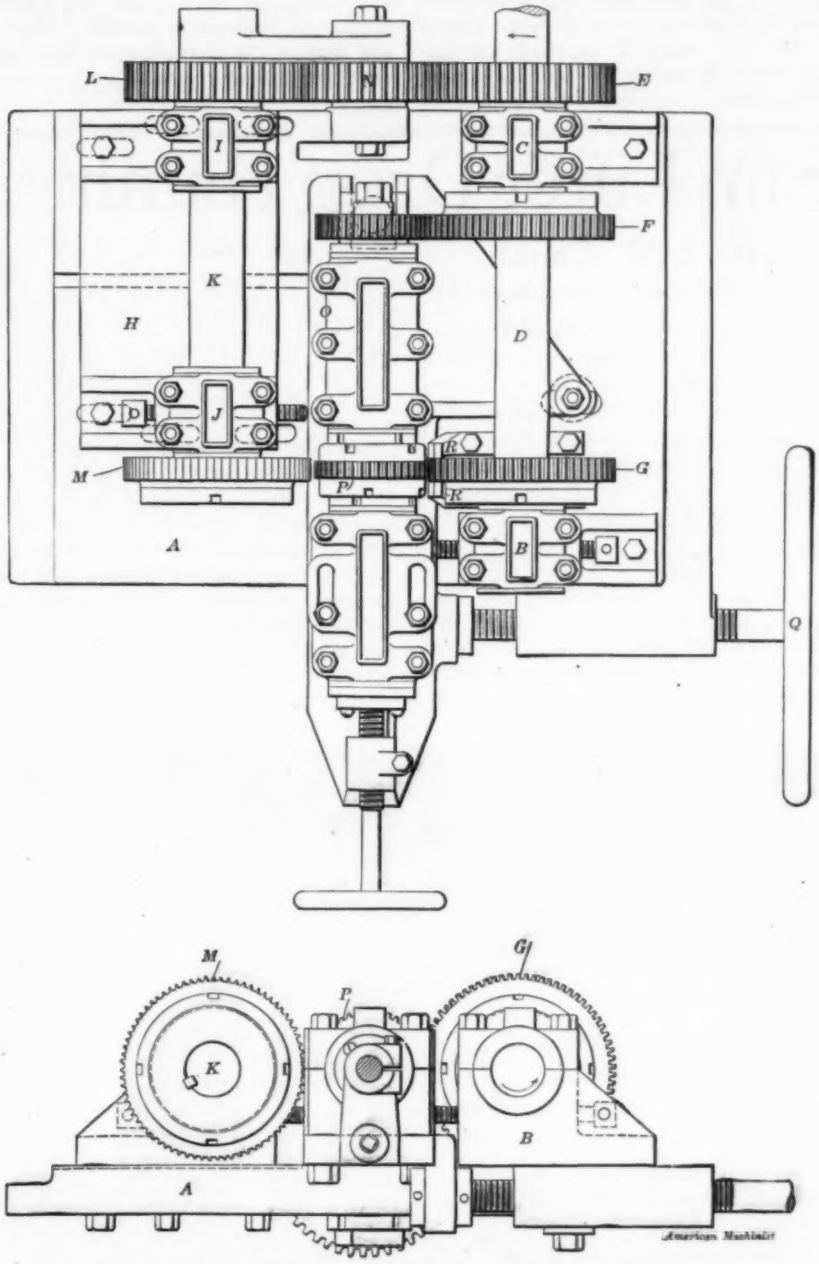


FIG. 2. DETAILS OF MACHINE FOR ROLLING THE TEETH INTO GEAR BLANKS

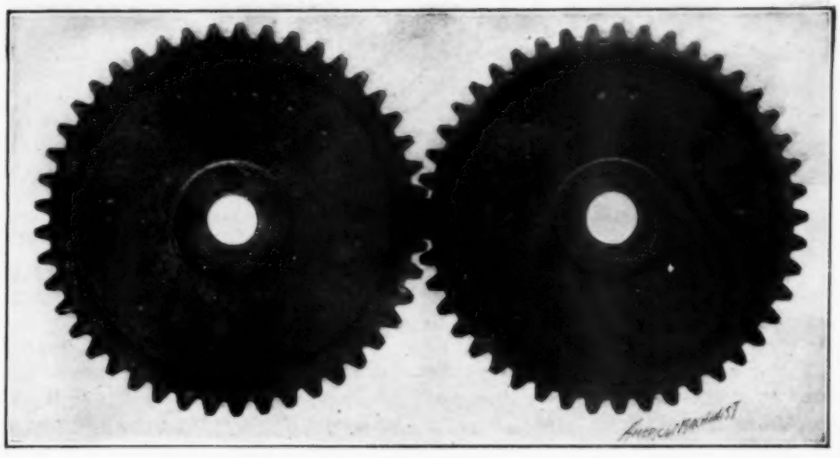


FIG. 3. A PAIR OF ROLLED SPUR GEARS

proper distance between the gears L and N, and when the plate H is moved the gears E and N remain properly enmeshed.

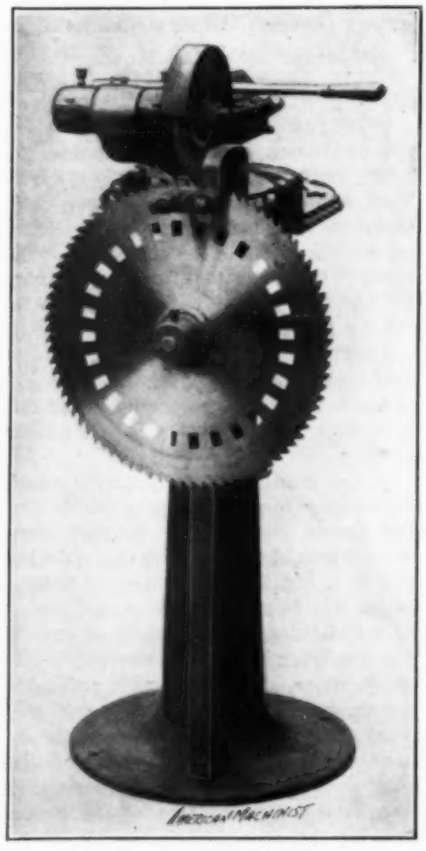
A plate O rests upon the base A and is adapted to oscillate slightly, the construction of its pivot being such as to permit of longitudinal movement of the plate, as well as lateral adjustment of both pivot and plate.

In practice the blank P is placed between the collars as shown, and the machine started. The plate O carrying the gear-blank holding mechanism is then forced by the hand wheel and screw Q against the breaking-down roller M, which partially forms or "roughs" the teeth. It is, of course, understood that the blank P is so synchronized with the roller M that their peripheries travel at the same speed.

When the breaking-down operation is completed, the blank is forced against the finishing roller G, which completes the forming of the teeth. The surplus metal from the tooth spaces forms on each side of the rim of the blank and is removed by forcing it against the shearing tools R. The finished blank is then removed from the holder.

Hunter Saw Sharpener

The halftone shows a saw-sharpening machine, built by the Hunter Saw and Machine Company, Pittsburg, Penn.



THE HUNTER SAW SHARPENER

The emery wheel arbor is supported on both sides of the pulley by adjustable bearings. The ram is square, set so that a vertical line passes through two vertical corners and the center. It is held down by an adjustable cap with liners and is moved by the hand lever shown.

The saw arbor is adjusted approximately by hand on the vertical square shaft, further adjustment being made by screw and hand wheel. Indexing is automatic. In addition to gumming, facing and topping the teeth, this machine will bevel the cutting points of teeth of milling saws.

Improved Steam Lifter Drop Hammer

By I. W. Chubb

An English drop hammer having a steam lifting mechanism. The lifting piston is a vane swinging in a cylindrical casing and controlled by a hand operated slide valve designed to give sensitive control and expansive operation of the steam.

Bretts Patent Lifter Company, Ltd., Coventry, has recently constructed for a Manchurian railway company, two steam hammers of a type different in detail from anything yet made. They supply an elastic, gravitation blow and it is largely to this type of blow, it is believed, that progress in forming metals has been due during the last few years. Such a blow is necessary for stamping in dies, and the makers themselves seem to hold that it is equally necessary for ordinary forging purposes, where flat pallets and smith's sets are used.

Apparently, in most cases, a double-acting steam hammer has been regarded as the standard type of tool for smithy purposes. In the steam hammer the falling parts are accelerated by steam, and at the moment of the blow the tup, piston rod and piston form, as it were, a solid body from tup to piston head. The tendency, therefore, is to crystallize and break up the rod at the end keyed into the tup, and to prevent this, the base block usually rests upon a cushion of timber. This relieves the piston rod of some of the shock but making the anvil springy obviously detracts from its rigidity. The general effect of the blow is therefore diminished. Much the same applies to compressed-air hammers.

In the Brett mechanism there is a flexible connection between the tup and the lifting mechanism; consequently the base block can be placed directly upon solid concrete, the anvil being an unyielding mass without risk to the vital parts of the stamp. It is true that, as steam cannot be admitted to the back of the piston for the purpose of accelerating the falling parts, there may be a little loss in speed, but somewhat more than compensation is thought to be obtained, and this is in large measure the basis of the Brett practice.

In the latest Brett hammer the steam cylinder for the lifting mechanism is similar to that used in the ordinary Brett drop stamp, but a patent valve device, shown in Fig. 2, is now fitted. After the steam has been admitted to the port *A* on the under side of the piston or vane *B*, and the lever has swung around, raising the hammer, the spent steam occupying the space between the piston and stop block, instead of passing at once into the atmosphere on the return piston oscillation, or stroke, moves around through a port to the opposite side of the piston, keeping this in equilibrium. The object is to insure that there shall be no drag whatever on the hammer in its fall. Thus steam, after being admitted by the inlet port is cut off, and inlet and outlet ports are placed in direct communication by means of the valve, while the exhaust to the atmosphere is closed. On return movement of the valve, both exhaust to atmosphere and admission of steam to the vane are permitted.

The tup is sensitively controlled by hand lever, the driving lever being moved upward or downward as it is desired to lift or drop the falling parts. The lift is thought to be quicker than the upstroke of the steam stamp. The descent is, as stated, simply by gravitation. The smallest hammer yet built on this principle has a falling weight of 2800 pounds, and from 80 to 100 blows a minute can be obtained. The impact can be regulated and the whole speed of the hammer is held to be at least equal to that of a double-acting steam hammer of the same weight.

Steam being used only to raise the hammer, the consumption is obviously halved as compared with that of a double-acting hammer. The makers have, in fact, found that rather less than half is used. Indicator diagrams showed that considerable expansion is obtained after cut off. The steam in one instance was admitted at 74 pounds and, when finally swept out into the atmosphere by the release pressure was 36 pounds.

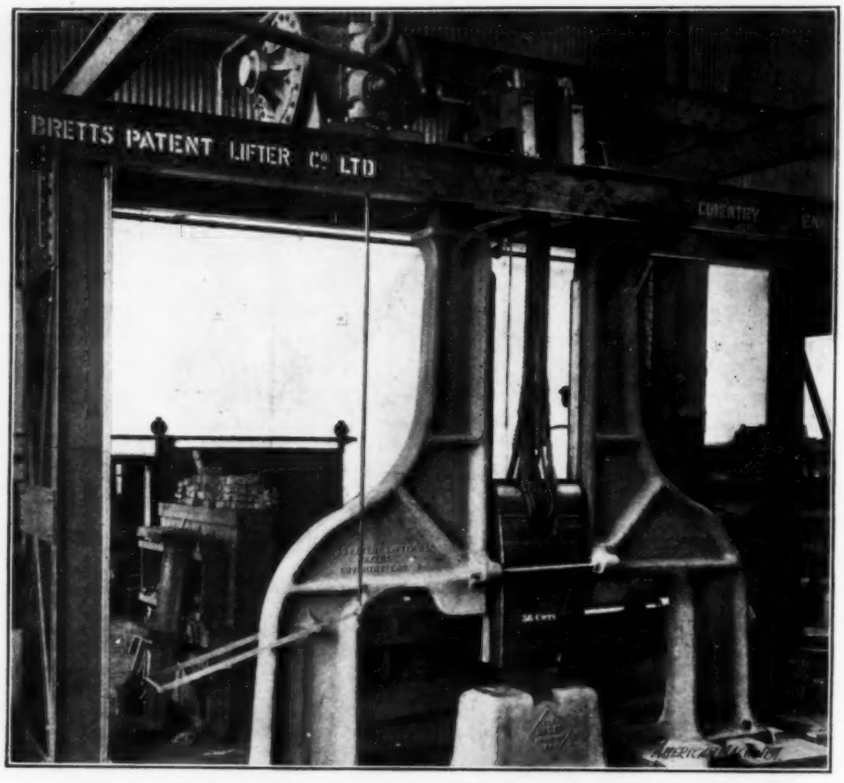


FIG. 1. BRETT STEAM-LIFTER DROP HAMMER

For fagoting or balling, this type of hammer is thought to be particularly suited. Recognizing that the best iron is made by elastic blows, many firms still use the old helve hammer. This cannot be called economical. In balling, the fagot, when

hammered together and getting cold, presents a somewhat refractory resistance to the blow. The fact that the base block of the hammer is solid insures that the energy of the blow shall be spent upon the work, and not in driving the base block onto a timber cushion.

In Fig. 1, the hammer has a tup of 6300 pounds weight, without the pallets. Two separate sole plates are harnessed together and the overhead mechanism is carried separately by steel standards. The stamp can be driven from either side. The ends of the guide rods fit into wrought-iron sockets, and wooden wedges fix them and prevent vibration reaching the upper parts of the stamp.

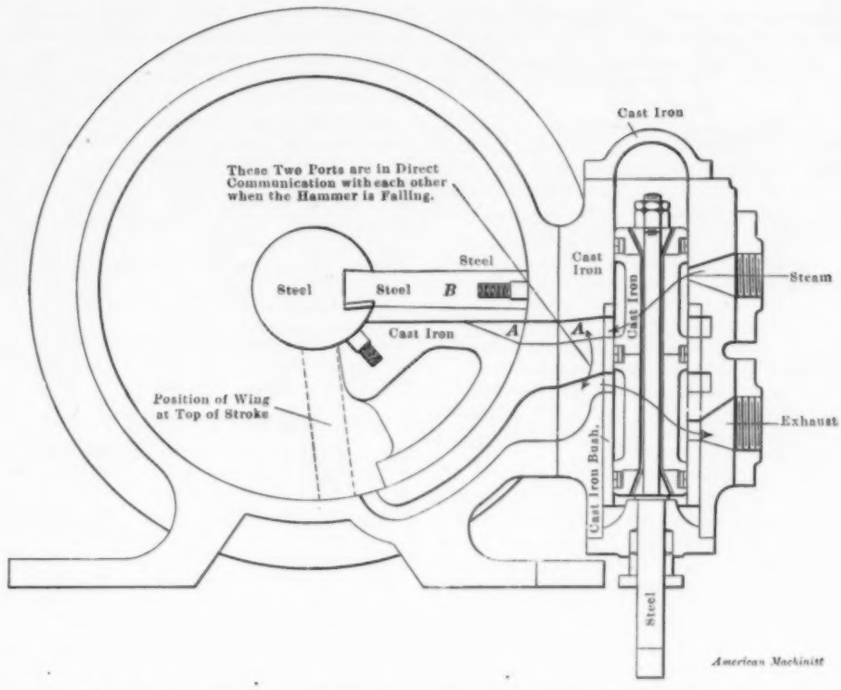


FIG. 2. CYLINDER AND VALVE MECHANISM OF STEAM-LIFTER GEAR

Buying and Selling

BY JOHN R. GODFREY

Whether money is "the root of all evil" or not, there are some wofully twisted ideas in regard to buying and selling which are largely caused by the way we use it.

The man who has a machine to sell, no matter how good it may be, is all too apt to feel under obligations to the man who buys it, when, as a matter of fact he may have done him the greater service by selling it to him. If the machine will earn a fair return on the price asked for it, the buyer should be just as much in need of it as the seller is of the order and there should be no feelings of obligation on either side. If the machine will not return a fair profit, it should not be bought at any price because the maker is a good fellow or because he uses one of your machines. Every machine should be bought for its fitness of the work at the price asked and regardless of its being built in Hackensack or any other "home town."

But unfortunately pay day comes around with astonishing regularity, and men have to have real money to buy shoes for the children, and the man who has the coin or its equivalent, can talk a good deal louder than he ought to.

When we learn that both sides of a deal should be equally profitable to the participants, we shall do business in a more businesslike way.

Increasing Shop Capacities

METAL WORKING

NEW ENGLAND

The Spencer Wire Works, Worcester, Mass., will build an addition.

The Simplex Electric Company, Cambridge, Mass., will erect a foundry.

The Hallum-Rice Company will establish a jewelry plant in Providence, R. I.

A. Schweitzer & Son will establish a jewelry shop in the Metcalf building, Providence, R. I.

The Eastern Bridge and Structural Company, Worcester, Mass., is erecting an addition.

L. R. Stanley will erect a new shop in Salem, Mass., for the manufacture of marine engines.

The Narragansett Machine Company is erecting an addition to its plant in Woodlawn, R. I.

The Rhode Island Tool Company, Providence, R. I., is to make extensive alterations to its plant.

The Gosnold Company, New Bedford, Mass., is to erect additions to the carpenter and machine shops.

The Manufacturers Jewelry Refining Company, Providence, R. I., is to erect an addition to its plant.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

The Exeter (N. H.) Machine Works has purchased a plant in Hyde Park, Mass. Will equip same shortly.

The Lamson Consolidated Store Service Company, Lowell, Mass., is planning to erect additions to its plant.

The Frederick Sheidel Company, a German concern, will establish a jewelry shop in the Wall building, Providence, R. I.

The A. T. Wall Company, Providence, R. I., manufacturing rolled plate and wire, will move its plant to the new Wall building.

The Farnham Cam Jack Company will establish a manufacturing and general machine-shop business at Rumford Falls, Me.

The Boston State Hospital, Dorchester, Mass., will soon have a list of requirements ready for its machine and carpenter shops.

The Burgess Automobile Company, Portland, Me., has been incorporated to manufacture automobiles. Capital, $10,000. Clarence W. Small, president.

MIDDLE STATES

The Pittsburg (Penn.) Water Heater Company will erect a new plant.

The Belvidere (N. J.) Water Company will build a new pumping station.

The Clark Company, Pittsburg, Penn., is looking for a site for a new plant.

Blackburn & Turner, Ellwood City, Penn., are building a new machine shop.

The Havers Automobile Company is building a large factory at Port Huron, Mich.

The McKeesport (Penn.) Tin Plate Company will add possibly four new hot mills.

The Chicago Steel Car Company will expend $75,000 in improvements to its plant at Harvey, Ill.

The Ellwood City, (Penn.) Iron and Wire

Company will make additions, doubling the capacity of its plant.

The Stuyvesant Motor Car Company, Cleveland, Ohio, is looking for suitable location on which to erect a plant.

The Boyertown Casket Company expect to install two new engines in its plant at 1217 Arch street, Philadelphia, Penn.

The Detroit (Mich.) United Railway will erect a plant for building and repairing cars, trucks, motors, at Highland Park.

The plant of the Phœnix Wire Works, at Kirby avenue and Dequindre street, Detroit, Mich., was burned. Loss, $20,000.

The Michigan Crank Shaft Company, Muskegon, Mich., has decided not to build its proposed new factory until the spring.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids Nov. 1 for one portable boring bar as per Schedule No. 2991.

The capital stock of the Alton Motor Accessory Company, of Akron, Ohio, has been increased from $50,000 to $100,000 to provide for more facilities.

The Reimers-Mair Biplane Company, Chicago, Ill., has been incorporated to manufacture airships. Capital, $25,000. F. C. Reimers, A. P. McArthur, J. E. Mair, incorporators.

The Commercial Register Company, of Buffalo, which recently was merged with the Benjamin Account System Company, of Rochester, N. Y., will move its plant to the latter place.

The Virden Equipment Company, Camden, N. J., has been incorporated with $50,000 capital to manufacture electrical machinery. Incorporators, Albert M. Ward, Wm. S. Wood, E. Lawrence Dudley.

The V. V. Fittings Company, Trenton, N. J., has been incorporated to manufacture electrical and mechanical specialties. Capital, $120,000. Incorporators, James P. Burns, Wm. T. Pringle, Wm. Gloeckner.

Ripley Foundry and Machine Company, Ripley, Ohio, has been incorporated to do a general foundry and machine business by Robert L. Russell, Walter L. Russell, Harry L. Russell Frank M. Russell, etc. Capital, $30,000.

The Rapp Motor Company, Detroit, Mich., has filed articles of incorporation and will establish a plant for the manufacture of motors for automobiles, launches, etc. Jas. H. Christian, 93 Blaine avenue, is one of the stockholders.

The Peerless Machine and Stamping Company, Cleveland, Ohio, has been incorporated to manufacture and sell machines and do a stamping business. William S. Steinbrenner, George A. Switzke, J. A. Lannert, etc., incorporators. Capital, $10,000.

The Dusseau Fore and Rear Drive Auto Company, Toledo, Ohio, with $100,000, has been incorporated to manufacture and sell automobiles and other motor vehicles by W. V. Dusseau, A. J. Marleau, Martin Christy, M. G. Dusseau, Vincent J. Schlachter and L. F. Consino.

The Toledo Carburetter Company, Toledo, Ohio, has been incorporated with $1000, preliminary capital, to manufacture and sell carburetors and other automobile accessories. E. E. Barthelomew, Edward Younger, W. K. Caldwell, W. R. Winn and F. G. Castle, incorporators.

The Enterprise Brass and Plating Company, Cincinnati, has been incorporated to manufacture and sell carriage and automobile mountings and to make auto supplies. Incorporators, M. Charles Weiglein, C. J. Peimekamp, George Apple and M. C. Weiglein. Capital, $25,000.

The Powell Engine Corporation, Brooklyn, N. Y., has been incorporated to manufacture machinery, engines, etc. Capital, $50,000. Incorporators, Luther P. Powell, Royiston W. Powell, 161 Bay Thirty-fifth street; Chas. I. McLaughlin, 8730 Bay Twenty-fourth street, Bensonhurst, N. Y.

The Mesha Manufacturing Company, New York, has been incorporated to manufacture hardware, metal office supplies, etc. Capital, $50,000. Incorporators, E. H. Taylor, Jr., 1419 Eighth avenue; W. D. Mackey, Jr., 988 Bergen street; Louis C. Wagner, 1066 Park place, all of Brooklyn.

Ryder Brass Foundry Company, Bucyrus, Ohio, has been incorporated to manufacture and sell bronze and aluminum castings and do a general machine business. Incorporators, Parmley H. Ryder, Arnold Lentz, Elizabeth W. Ryder, Alfred S. Lenthold and Samuel Lenthold. Capital, $10,000.

SOUTHERN STATES

The Baltimore & Ohio Railroad will erect a building at Keyser, W. Va., shops to be equipped for repairing steel cars.

The Malcom Brake Shoe Company, of Charleston, W. Va., has been incorporated to manufacture brake shoes. Capital, $25,000. Incorporators, C. A. Malcom, of Meriden; T. Mairs, S. B. Avis, Waller Hardy, A. E. Scherr, of Charleston.

WEST OF THE MISSISSIPPI

The Hawkeye Pump Company, of Fairfield, Iowa, will erect a two-story building.

A cornice shop will be built on East Twelfth street, Los Angeles, Cal., by J. Rosen.

The Cement Machinery Corporation, Waterloo, Iowa, has increased its capital stock and will build a new factory.

The Butler Manufacturing Company, Kansas City, Mo., has purchased site for a new factory for the manufacture of galvanized steel products.

The Pacific Garage, at Long Beach, Cal., was destroyed by fire on October 5. Besides a loss in automobiles, machinery and tools, valued at $2000, were demolished. The shop will be rebuilt.

The Colby Motor Company, Mason City, Iowa, a new concern, capitalized at $100,000, will erect a five-story factory. The incorporators are William Colby, James Colby, I. W. Keerl, A. H. Gale, etc.

CANADA

The Montreal Taxicab Company will equip a plant at Montreal.

The Vancouver Engineering Works is extending its plant at Vancouver, B. C.

The Toronto Wire and Iron Works will locate a branch factory at Regina, Sask.

The Niagara Brass Bedstead Company will erect a large factory at Brantford, Ont.

The King Radiator Company, of Toronto, is making large extensions to its plant.

The Doty Engine Works, of Toronto, will build a large shipbuilding plant at Winnipeg.

The Alberta Iron Rolling Mills Company will build a large plant at Medicine Hat, Alberta.

The Penberthy Injector Company, of Walkerville, is making large extensions to its factory.

The National Wire Fence Company, of Prescott, Ont., will establish a branch at Regina, Saskatchewan.

The Niagara Welland and Lake Erie Railway, of Niagara Falls, is in the market for supplies and equipment.

The Grimm Manufacturing Company, manufacturers of sugermakers' supplies and evaporators will locate at Montreal.

The Canadian Tube and Iron Company, Ltd., Montreal, Canada, has been incorporated with $1,000,000 capital by Geo. V. Cousins and Samuel T. Mains.

The Transcontinental Railway Commission, Ottawa, is calling for tenders for new machinery for the Transcontinental Railway roundhouses and shops.

GENERAL MANUFACTURING

NEW ENGLAND

Ernest W. Tinkham will erect a worsted mill at Harrisville, R. I.

The Clark Mills, Westerly, R. I., will improve its electric-light plant.

The Oxford Linen Mills, North Brookfield, Mass., is enlarging its plant.

The Stanley Company, Salem, Mass., will install an electric generating plant.

C. P. Darling & Co., Providence, R. I., box manufacturers, will enlarge their plant.

The Soule Milk Company, New Bedford, Mass., is preparing plans for an addition.

The Livingston Worsted Company, Washington, R. I., will improve its dye house.

The Bates Manufacturing Company, Lewiston, Me., it is said, will erect a new mill.

The Farwell Bleachery Company, Lawrence, Mass., is to erect an addition to its mill.

The plant of the Hub Engraving Company, Boston, Mass., was burned. Loss, $25,000.

The Aspinook Company, Jewett City, Conn., is having an engine house added to its plant.

J. J. Adams, Mechanic street, Worcester, Mass., will install a low-pressure steam boiler.

The S. H. Couch Electric Company, Boston, Mass., will erect a factory at Norfolk Downs, Mass.

The Allerton Worsted Mills, Lowell, Mass., will build a mill for the manufacture of yarns.

The Lafayette Worsted Company, Woonsocket, R. I., is to build an addition to its plant.

The plant of the Vera Chemical Company, Stoneham, Mass., was destroyed by fire. Loss, $25,000.

A press mill of the American Powder Company, Acton, Mass., was destroyed by explosion.

The Williams Manufacturing Company, Northampton, Mass., is to erect a new basket factory.

The Felt and Rubber Company, Webster, Mass., is in the market for electric motor and boiler.

The factory of the Cambridge Gas Light Company, Cambridge, Mass., was badly damaged by fire.

The C. W. Dean Company, of Cochituate, Mass., is preparing to move its shoe factory to Natick, Mass.

The Massachusetts Agricultural College, Amherst, Mass., is in the market for steam engine and pump.

Fire did about $10,000 damage to the morocco factory of Edward W. McCarthy & Co., Peabody, Mass.

The American Thread Company will install bleaching and dyeing apparatus in its mill at Willimantic, Conn.

A. & E. Hendels Lace Company, Bridgeport, Conn., is to double the size of its plant and install new machinery.

John Quin & Sons, Cambridge, Mass., manufacturing moldings, etc., are building an addition to their shops.

The Edwards Manufacturing Company, Augusta, Me., cotton goods, is having an addition added to its factory.

The United States Government is erecting a pump house at Bradford, R. I., for which machinery will be required.

The Hingham Knitting Company, Hingham, Mass., has completed extensive alterations. Will install new machinery.

The Young Men's Christian Association, Beverly, Mass., will erect a new building and require steam-heating apparatus.

The United States Cotton Company, Central Falls, R. I., has leased land to be used in connection with its power plant.

The New York, New Haven & Hartford Railroad is to erect a grain elevator at Pawtucket, R. I. Capacity, 30,000 bushels.

The Shambow Shuttle Company, Woonsocket, R. I., is having new additions added. Electricity will furnish power throughout.

The Booth Manufacturing Company, New Bedford, Mass., is building a new plant, including weave shed, spinning mill and power plant.

The New Hampshire Electric Railway, Haverhill, Mass., is in the market for a 500-horsepower boiler with superheaters and stoker.

Julius Garst, of Worcester, Mass., has purchased the factory formerly occupied by the Litchfield Cushion Heel Company and will engage in the manufacture of porch shades. Machinery will be equipped for motor drive.

MIDDLE STATES

Peekskill, N. Y., is increasing the capacity of its pumping station.

The Bradley Knitting Works, of Delevan, Wis., will erect an addition.

The Geneva (N. Y.) Glass Works is building a large addition to its plant.

The National Casket Company, Pittsburg, Penn., will erect a five-story addition.

The Geer Hydro-Electric Power Company, Troy, N. Y., will erect a power plant.

The Utica (N. Y.) Novelty and Mill Specialty Company will enlarge its plant.

The Peoples Water Company, Phillipsburg, N. J., will build a new pumping station.

The National Condensed Milk Company, of New London, Wis., will erect an addition.

Fire destroyed the plant of the Greenville Coal and Ice Company, Jersey City, N. J.

Fire destroyed the brick plant of Thompson & Wills, Royersford, Penn. Loss, $10,000.

The Ferggs Brewing Company, Newark, N. J., will remove its plant to Oneonta, N. Y.

Richard Welford, of Fairchild, Wis., is considering the erection of a cheese factory.

Fire partially destroyed the plant of the Buckeye Stave Company, at Perberville, Ohio.

The Fort Wayne (Ind.) Electric Works is building an addition which will double its capacity.

Fire destroyed the plant of the Crew-Levick Oil Company, Jersey City, N. J. Loss, $50,000.

The G. Edwin Smith Shoe Company, of Newark, Ohio, will soon start an addition to the plant.

W. E. Friese, Milton, Penn., manufacturer of bricks, is in the market for a 100-horsepower engine.

Power plant and warehouse of the Smith Paper Company, Camden, N. Y., was destroyed by fire.

The B. F. Goodrich Tire Company, of Akron, Ohio, will establish a branch factory in Des Moines, Iowa.

The McCarthy Improvement Company, of Davenport, Iowa, has plans for the erection of a modern asphalt plant.

Plans have been filed for a $20,000 blowing engine house by the American Steel and Wire Company, Cleveland, Ohio.

J. Ruth, 1036 Hanover street, Baltimore, Md., is interested in the establishment of a canning factory and packing plant.

Fire did $10,000 damage to the plant of the Great Northern Plating Company, 314 North Carpenter street, Chicago, Ill.

Hochschild Kohn Company, department store, Baltimore, Md., will install two new engines and dynamos in the near future.

The town of Mifflinburg, Penn., is considering the installation of an electric-light plant. Enoch Miller is president of the board of trade.

A special election has been called in Geneva, N. Y., to vote on the question of constructing new waterworks pump station and water mains.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids November 1 for furnishing and installing crane and trolleys as per Schedule No. 2973.

One of the departments of the Sam George Paper Company, at Wellsburg, Ohio, was destroyed by fire recently, entailing a loss of $10,000. The department will be rebuilt at once.

The Hygienic Ice Company, Chicago, Ill., has been incorporated to manufacture ice, distilled and carbonated waters. Capital, $200,000. Incorporators, H. J. Aaron, Albert Bettcher, Adolph Weinstein.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., November 7, for hose, hose couplings, oil cups, cocks, saws, chucks, reamers, punches, metallic tapes, etc., as per Circular No. 610.

The A. D. Coe Piano Company, Cincinnati, has been incorporated to manufacture and sell pianos. Capital, $50,000. A. D. Coe, Charles A. Burke, William M. Byrnes, J. A. Burke and Charles A. Aaron, incorporators.

The Columbus Shoe Company, Columbus, Ohio, has been incorporated with $25,000, to manufacture and sell shoes. P. A. Campbell, C. R. Campbell, J. W. Campbell, E. Fenton and J. William Campbell, incorporators.

The Royal Manufacturng Company, of Columbus, Ohio, was incorporated with a capital of $50,000, to manufacture gas mantels and fixtures, by J. D. Morse, W. D. Morse, Otto C. Darst, C. E. Somnanstine and A. W. Williams.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids November 8 for 5900 pounds sheet copper (schedule 2989), 9000 pounds medium steel, Class B, 21,000 pounds medium bar steel, 3500 pounds cold-rolled steel (schedule 2987).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids October 25, for 300 dozen hacksaw blades, files, rasps (schedule 2978): 247 sets lightning, patent machine relieved hand taps (schedule 2975), 75,000 pounds manganese bronze in ingots, 5000 pounds monel metal, steel forgings (schedule 2974), 50,000 pounds medium channel steel, 6350 pounds medium molding steel, 236,000 pounds angle steel, medium, black, 24,400 pounds medium galvanized angle steel, 2000 pounds medium bar steel, 28,000 pounds medium beam steel, 8000 pounds galvanized sheet steel, 43,100 pounds galvanized sheet steel, 244,000 pounds black plate steel (schedule 2982), 6000 pounds medium bar steel (schedule 2985).

SOUTHERN STATES

The Armour Packing Company will erect a plant in Alexandria, La.

The plant of the H. L. Judd Curtain Pole Company, at East Chattanooga, Tenn., was destroyed by fire. Loss, $200,000.

The Standard Oil Company will double the size of its plant at Baton Rouge, La. Is also erecting a large paraffin plant in which a 150-ton refrigerating machine will be installed.

WEST OF THE MISSISSIPPI

Walter & Co., of Clinton, Iowa, will erect a candy factory.

O. C. Gould & Son, of Fairmont, Minn., will erect a cement block factory.

Bernard & Stady, of Belle Fourche, S. D., will rebuild their flour mill.

The McGinnis Creamery Company will erect a new plant at O'Neill, Neb.

The Ritchie Corrugated Culvert Company will erect a plant at Muscatine, Iowa.

Fire destroyed one-half of the plant of the Lanyon Zinc Company, La Harpe, Kas.

Wall Brothers, of Koszta, Iowa, are building an addition to their blacksmith shops.

The plant of the Great Bend (Kas.) Ice and Fuel Company, destroyed by fire, will be rebuilt.

The Pacific Tank Company, of Los Angeles, Cal., will erect a plant at Vernon (near Los Angeles), Cal.

The Black Hills Pressed Brick Company, of Rapid City, S. D., is making extensive additions to its plant.

The San Pedro, Los Angeles & Salt Lake Railroad Company will erect a packing house at Arroyo Park, Cal.

Power-plant equipment will be required in the new city-hall building to be erected at South Pasadena, Cal.

National Woodpipe Company, of Los Angeles, Cal., will erect a plant at Vernon, Cal. (near Los Angeles).

The National Rubberette Company, of Des Moines, Iowa, is considering the erection of a plant at Davenport, Iowa.

A modern warehouse will be erected at Ninth and Mateo streets, Los Angeles, Cal., by the Houser Packing Company.

The General Fertilizer Association will erect a large warehouse at San Bernardino, Cal. Modern equipment will be installed.

The Fullerton Ice Company has completed an ice-making plant at Fullerton, Cal. The plant will be of ten tons daily capacity.

Heating equipment will be required in the new hotel to be erected at San Diego, Cal., by Mrs. Louise Bloesier, of Los Angeles.

Plans have been completed for the new $1,000,000 factory for the National Biscuit Company, to be erected in Kansas City, Mo.

The Chrystal Lake Distillery, of South Sioux City, Neb., is making additions and improvements to its plant to cost $20,000.

The Fontana Development Company, of Rialto, Cal., will expend $250,000 in perfecting a water-supply system for irrigation purposes.

The Floriston Pulp and Paper Company, Los Angeles, Cal., will erect a warehouse 80x150 feet. Modern equipment will be required.

The new College Theatre, Los Angeles, Cal., for which plans are now being drawn, will have a complete system of ventilation installed.

The West Ontario Citrus Association, of Narod, Cal., will enlarge its packing house in Los Angeles and install additional machinery.

The Pacific Coast Planing Mill Company will erect a planing mill at Vernon, Cal., in the near future. The company is located in Los Angeles.

Power-plant equipment will be required in the new tourist hotel to be erected at Monrovia, Cal., by L. B. Vollmer and associates, of Los Angeles.

The contract has been let for the new high-school building, at Whittier, Cal. A complete system of heating and ventilation will be installed.

The James Evergreen Company, candy-makers, Los Angeles, Cal., will erect a large factory devoted to this industry on Third street. Equipment will be required.

The Wilmington Dock Company has begun the erection of a hotel at Wilmington (Los Angeles), Cal. The building will cost $20,000. Modern facilities will be installed.

The packing house of the Pachappa Orange Growers' Association, at Riverside, Cal., was destroyed by fire, including packing machinery, $8000. The plant will be rebuilt.

A soap factory will be erected at Vernon, Cal., by Henry Blumenberg and associates, of Los Angeles, Cal. Both power plant and soap-manufacturing machinery will be required.

The Bellingham (Wash.) Manufacturing Company has commenced the construction of a plant on Maple street. Complete line of woodworking machinery will be installed.

Power-plant equipment will be required in the new Santa Paula hotel to be erected for the Santa Paula Hotel Company. Hunt & Eager, Los Angeles, Cal., are the architects.

M. A. Newmark & Co., Los Angeles, Cal., wholesale grocers, will build a five-story building at Sixth and Mill streets. The equipment for handling material will be complete.

The Consolidated Gas Company, Long Beach, Cal., has purchased four acres of property from the Inner Harbor & Edison Companies and will erect a plant in Los Angeles.

A. Ramish, of 316 South Main street, Los Angeles, Cal., will erect a theatre to cost $100,000. Plans are now nearing completion. Heating and ventilating apparatus will be required.

Heating apparatus will be required in the new St. Mark's Lutheran Church to be erected in Los Angeles, Cal. H. M. Patterson, of Los Angeles, is architect; plans are nearing completion.

Wm. Binder, architect, San Jose, Cal., is now taking bids on a warehouse to be erected in Los Angeles for the Keystone Company. It will cost $30,000. Modern facilities will be installed.

Power-plant equipment will berequired in the 10-story and basement office building to be erected at Broadway and Second streets, Los Angeles, Cal., by the Broadway Investment Company.

The contract has been let for the new Y. M. C. A. building to be erected at Pasadena, Cal., to the J. A. Harmon Company, of Los Angeles. Price, $89,606. The equipment will be thoroughly up to date.

The patents and interests of George Gates, of Stockton, Cal., in the Gates patent concrete ties, have been sold for $17,500,000. Plants will be erected at Stockton, Los Angeles and Oakland, Cal. Mr. Gates will be general superintendent for the first year.

CANADA

W. McDougall will build a large planing mill at Berlin, Ont.

The Winnipeg Tanning Company will equip a $300,000 plant at Winnipeg.

The Burlington Windsor Blanket Company will locate a plant at Windsor.

Niagara Falls, Ont., will make extensive additions to its waterworks plant.

The Toronto Furniture Company is building a large new factory at Toronto.

The Sidney Electric Power Company will locate a $500,000 plant at Belleville.

The Canada Reflector and Mirror Company will build a large factory at Hamilton.

Calgary, Alberta, is in the market for full equipment for an electric street railway.

The Niagara Bedstead Company, of Buffalo, N. Y., will erect a factory at Brantford, Ont.

The North American Furniture Company is building a large factory at Owen Sound, Ont.

The Red Cliff Brick and Tile Company will equip a very large plant at New Westminster, B. C.

The Chemical Laboratories Company will fully equip a very large plant at Welland, Ont.

The St. Lawrence Milling Company will spend $75,000 equipping a new mill at Montreal.

The planing mills of W. H. Cushing, at Regina, Saskatchewan, will be greatly enlarged.

Winnipeg will buy a 115-horsepower, 60-cycle induction motor and silent chain drive therefor.

The Glidden Varnish Company, of Cleveland, Ohio, is building a large plant at Toronto.

Chas. Reid & Son, paper-box manufacturers, Hamilton, Ont., will erect a $300,000 factory in Winnipeg.

The P. L. Robertson Company, of Milton, Ont., is building a large wire-drawing plant and a new power house.

The Cluett-Peabody Company, of New York, manufacturing shirts, collars, etc., will erect a plant in St. Johns, Ont.

The Canford Sawmill Company will buy $25,000 worth of the latest machinery for its new mill at Canford, B. C.

The Maple Grove Lumber Company's Mills, at New Westminster, B.C., which were completely destroyed by fire, will be rebuilt.

BUSINESS ITEMS

The J. S. Bretz Company has opened up a western office and sales room at 1215 Woodward avenue, Detroit. H. J. Porter and J. W. Hertzler, the western sales representatives of the J. S. Bretz Company, will make their headquarters at the new address and show a complete line of F. & S. annular ball bearings, German steel balls, U. & H. master magnetos and Bowden wire.

FORTHCOMING MEETINGS

International aviation meet, Belmont Park, Long Island, October 22 to 30. Auspices of the Aëro Club of America, 29 West Thirty-ninth street, New York City.

National Machine Tool Builders' Association, annual meeting, October 25-26, Hotel Astor, New York. Chas. E. Hildreth, secretary, Worcester, Mass.

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers, annual meeting, December 6-9, New York. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Foundrymen's Association, annual convention, Pittsburg, Penn., May 23 to 26, 1911. Richard Moldenke, secretary, Watchung, N. J.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Philadelphia Foundrymen's Association; meetings first Wednesday of each month, Manufacturers Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

MISCELLANEOUS WANTS

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

The "Gas Saver" brazing forge; circular. J. L. Lucas & Son, 2 Fox St., Bridgeport, Ct.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Wanted—Medium weight specialties or contract work. Wm. A. Cather, Pottsville, Penn.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Let us be your factory; anything in metal; small work a specialty. P. O. Box 284, Anderson, Ind.

Will Mr. Brown Jackson communicate with Ed. Montague, Supt. Holm's Machine Mfg. Co., Sparta, Mich.

If you want special machinery or tools designed, I can give you satisfactory service. Box 39, AMERICAN MACHINIST.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—One second-hand boring and turning mill in first-class condition; 60-inch swing, two heads on cross rail. Box 21, AM. MACH.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Machinery and manufacturing plants, designed, constructed, examined and reported on. A. W. Jacobi, Engineer, 192 Market St., Newark, N. J.

Wanted—Automatic screw machine work, up to and including 9/16-inch diameter, for latest multi-spindle machines; prompt deliveries and reasonable prices. Woburn Gear Works, Nashua St., Woburn, Mass.

Large English firm of machine tool importers having showrooms and offices in Great Britain, France, Germany, Italy, India and Japan is wanting good agencies for machine tools of all kinds. Box 189, AMER. MACH.

Wanted—160,000 lineal feet of square pipe or tubing, 1¼x1¼x1/16 inches thick, to be used for cross-piling strips between lumber; manufacturers will be put into communication with purchaser by addressing "X Y Z," Box 62, AMERICAN MACHINIST.

Those breaks on power plant or machinery! Are you going to lose time awaiting new parts from makers, or will you let us weld them at one-fourth to three-eighths cost of replacements? Re-shipment within 24 hours. Oxy-acetylene process, producing homogeneous weld of cast iron. No charge unless successful. Waterbury Welding Works, Waterbury, Conn.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Draftsman used to marine engine and boiler work; state experience and salary expected. Collingwood Shipbuilding Company, Limited, Collingwood, Ontario, Can.

Wanted—Mechanical draftsman on jig and tool design and general mechanical shop equipment; give particulars of previous experience and salary expected. Box 70, AM. M.

INDIANA

Wanted—Four operators for Gleason bevel gear generators; four operators for Bilgram bevel gear generators; six operators for Brown & Sharpe automatic spur gear cutters; also one man capable of producing results that has had experience in all gear cutting lines, that would be capable of taking charge of large gear cutting department; none but first-class men need apply. 423 Johnson Block, Muncie, Ind.

MARYLAND

Wanted—Toolmaker, familiar with small subpress and jig work; must be capable of managing tool department. Box 86, AM. MA.

MASSACHUSETTS

Experienced cost clerk wanted; must have thorough knowledge of cost finding in machinery line; state age, experience, salary expected and references. Box 56, AMER. MACH.

Responsible position wanted by a practical shop man, expert toolmaker and designer of special machinery and equipment, with wide experience. Box 58, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Press room foreman; A-1 man on drawing dies of all kinds; fine opportunity for right man; state experience and salary expected. Box 78, AMERICAN MACHINIST.

Wanted—An experienced machinist with two helpers to do the machine work on repairs on contract or other suitable basis, for a general repair shop in Newark, established four years. Box 90, AMERICAN MACHINIST.

NEW YORK

Grinder hands wanted; good plain wet grinder hands; first-class men please apply. F. I. A. T., Poughkeepsie, N. Y.

Toolmakers Wanted—Large firm will pay 45c. per hour to first-class men; give age, experience and reference. Box 30, AM. MA.

Tool setter and operators wanted for Potter & Johnston semi-automatic machinery; first-class men please apply. F. I. A. T., Poughkeepsie, N. Y.

Wanted—Foreman for machine tool department, about 50 hands, steam and gas engine factory; applicants must be thoroughly experienced in handling men and equipment; state age, experience and references. Box 15, AMERICAN MACHINIST.

Wanted—A skilful press man, experienced in laying out operations, able to give instructions with reference to making punches and dies and accustomed to handling both power and hydraulic presses; an ambitious man, able to handle men, will be in line for quick promotion to the foreman of the press department; plant is in eastern New York State. Box 76, AMERICAN MACHINIST.

Wanted—A first-class man as assistant foreman in a large grinding department, doing a line of accurate, automobile work; only a man who has had experience as a foreman will be considered; no applications will be considered unless they give the following information: age, birth place, married or single, experience, names of firms by whom applicant has been employed during past seven years, in what capacity, wages expected to start, and when available. Address "Accurate," AMERICAN MACHINIST.

OHIO

Sales mechanical engineer producer and gas engine. Address "Salesman," Box 74, AM. M.

Wanted—Four or five first-class toolmakers; steady work. Kelly Motor Truck Co., Springfield, Ohio.

Wanted—Foreman, capable of taking charge of department making heavy sheet metal stampings and other sheet metal work. Box 83, AMERICAN MACHINIST.

Wanted—First-class foreman for automatic screw machines, by a large manufacturing concern, located in the Eastern Central States; must be very competent, familiar with Cleveland, Acme and Gridley automatic machines, on large work; we want to hear from live, capable men, stating salary, experience and references. Box 88, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Wanted—A first-class locomotive draftsman; one with experience in designing; state salary expected. Box 75, AMER. MACHINIST.

Wanted—Lathe, boring mill and floor hands for day and night work. Address the Jeanesville Iron Works Company, Hazleton, Penn.

Wanted—Two first-class draftsmen, on power plant and substation work. Send application, stating all details to Box 55, AM. MACH.

Machinist, first class of wide experience, required as inspector on machine tool work; state age, experience and salary expected. Box 77, AMERICAN MACHINIST.

Wanted—Draftsman capable of laying out work and designing on machine tools; must have shop experience; give references and salary expected. Box 79, AMER. MACHINIST.

Electrical or mechanical engineers wanted for hydroelectric development work; applicants must be neat draftsmen, preferably with experience in this line. Address application with full particulars to Box 54, AMER. MACH.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

RHODE ISLAND

Wanted—Experienced operators for universal boring machines. Box 82, AMER. MACH.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Superintendent or factory manager, thoroughly conversant with modern methods in manufacturing light or medium interchangeable work; twelve years' executive experience. Box 41, AMERICAN MACHINIST.

GEORGIA

Machine shop foreman desires change; good references. Box 32, AMERICAN MACHINIST.

ILLINOIS

Wanted—Position as superintendent or assistant, thoroughly conversant with piecework and uptodate methods of manufacture of interchangeable work; have had 18 years of general shop practice; A-1 organizer. Box 89, AMERICAN MACHINIST.

MASSACHUSETTS

Master mechanic, energetic, progressive and up to date, practical toolmaker and designer, experienced on accurate and interchangeable work; now employed but wishes change; best references as to ability and integrity. Box 80, AMERICAN MACHINIST.

Factory manager, successful, experienced in organization, cost and factory systems, desires change; can produce results and stand on own record, and give best references from present and past employers, also satisfactory reason for changing. Box 9, AMERICAN MACHINIST.

MICHIGAN

Draftsman, with experience on automobile and motor parts, desires a change; would prefer position as checker or layout man; can furnish good references. Box 81, AM. MACH.

NEW JERSEY

Mechanical engineer, chief draftsman and designer, steam, hydraulic and special machinery, is open for engagement. Box 71, AM. M.

Draftsman, experienced on jigs, fixtures, tools, also general shop and factory equipment, desires a position. Box 73, AM. MACH.

General foreman, 39, now engaged, accustomed to modern methods of manufacture, desires change. Box 61, AMERICAN MACHINIST.

Master mechanic, 38, several years' experience as foreman, capable of better job and wants it; knowledge of all around manufacturing; expert toolmaker, designer, inventive, adoptive; some technical knowledge, self acquired; good general education; some selling experience; inventor of a practical monoplane; present salary $1720. "Ambitious," Box 50, AMERICAN MACHINIST.

NEW YORK

Draftsman, experienced on tool designing; good mechanic. Box 72, AMER. MACHINIST.

Mechanical engineer, 12 years' experience along broad lines, is open for engagement. Box 22, AMERICAN MACHINIST.

Experienced mechanical man with executive ability solicits correspondence with manufacturing company requiring general foreman or superintendent. Box 901, AMER. MACHINIST.

Mechanical superintendent of a large manufacturing plant, with twenty years' experience in general machine and foundry practice, desires making a change. Box 901, AMERICAN MACHINIST.

Mechanical engineer, expert mechanic, designer and shopman with quick comprehension, 14 years' experience in designing manufacturing and lay out of tools, increasing production in machine shops, foundry and manufacturing plant, desires position. Box 85, AMERICAN MACHINIST.

General superintendent, high-class hustling, aggressive, energetic and economical; can crowd the work out and deliver the goods; meet competition in highly competitive lines; close at rating and estimating, designing tools, dies, machinery in any line of manufacture; never failed to surpass all expectations in making good my representations. Address "Mechanical Engineer," Box 84, AMER. MACH.

OHIO

Production engineer with 12 years' experience in responsible manufacturing and commercial positions, desires position as manager or superintendent. Box 66, AM. MACH.

PENNSYLVANIA

Cost accountant, thorough experience in machine shops and foundries, desires to change; references. Box 65, AMER. MACH.

Machinist, with four years' experience designing machine tools and jigs, drafting position in Middle West preferred; age 26. Box 49, AMERICAN MACHINIST.

Foreman, middle aged, now employed, latest methods, engineering, dynamos, electrical and general machinery; A-1 hustler; can handle force with executive ability. Box 87, AM. MA.

FOR SALE

For Sale—Patents of United States and foreign countries or interest in manufacturing company on coal distributing apparatus; first-class investment. "A. S.," AM. MACH.

For Sale—Very reasonable, almost new, boring bars: 8"x10', 6½"x9' 6", 3½"x4' 2", 2½"x3' 8½", with steam engine and complete set of patterns for casting of bars; can be seen at Hoboken, N. J. Address "Bargain," Care AMERICAN MACHINIST.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

Atlas Engine Works, Indianapolis, Indiana, offer for sale, surplus machine shop and boiler shop equipment: 52-inch Betts car wheel boring machine, with air crane attached, side head for facing, late design, heavy pattern; 48-inch Walcott shaper, with chuck, good as new; 24-inch x 8-foot American turret lathe, used eight months; No. 1¼ Beaman & Smith horizontal floor boring, milling and drilling machine, new and standard in every detail; four-motor Morgan electric traveling crane, 49-foot 3-inch span, 220 volts, direct current, main hoist 15 tons, auxiliary hoist five tons, Dinkey controller, General Electric motors, new; planers, shapers, hydraulic wheel presses, radial drills, overhead traveling drills, lathes, cylinder boring machines, vertical boring mills, punches, bending rolls, bevelers, air hoists, flanging machinery—all in unusually good operating condition.

Talks With Our Readers

By the Sales Manager

"I am glad to see that you also have a pay roll," said a large manufacturer after going through our plant some time ago.

Very few have an idea what a tremendous amount of work is necessary to issue each week a paper like the AMERICAN MACHINIST—it isn't a scissors and paste-pot job as the comic supplements would have us believe.

* * *

Do you realize that the American house of the Hill Publishing Company alone does over a million and a half dollars worth of business a year—it's the largest engineering publishing house in the world.

Its annual pay roll is over $400,000.

Its plant occupies 33,000 square feet of floor space.

And there's special machinery costing $168,000.

Over three and a half million copies of its three publications are sent out yearly—enough, if placed end to end, to make a path from New York to Detroit.

In printing these, over 450 two-horse wagon-loads of paper are used.

* * *

You have heard us say often that we pay for every line of contributed matter that we print. Do you know what that amounts to in a year?—$35,000.

And illustrating our editorial columns costs $28,000 yearly.

* * *

Yet with all this bigness ours is a business of infinite detail.

We have about 90,000 live, active customers all the time, and to render them prompt, reliable, efficient and courteous attention is the excuse for our business existence.

This keeps 263 salaried people busy.

And no work in our plant is done by hand that can be possibly performed by a machine.

There are no blonde or any other kind of stenographers—phonographic dictation only. And we receive an average of 1000 letters daily.

* * *

Ours is the only plant in the world that is completely equipped with sheet-fed rotary presses.

We have special machines to carry packages from floor to floor, to address wrappers, fold letters, seal envelops and lick stamps.

Come in and see them.

Look over our plant. See what a great cooperative institution it is.

Examine our lists of live readers.

See the thoroughness with which we scour the country to get the most reliable and up-to-date information for our papers.

Note the pains that is taken to keep out all fraudulent advertising and advertising of all products that do not pertain strictly to our fields.

Come in and see us whenever you are in this vicinity and then you will appreciate why both the reading and advertising pages of our papers are indispensable to their live readers.

A most hearty welcome awaits you.

* * *

Only reliable products can be continuously advertised.